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The American Heart Journal

VOL. 12 NOVEMBER, 1936 No. 5

Original Communications

A NEW METHOD FOR DETERMINING THE CIRCULATION TIME THROUGHOUT THE VASCULAR SYSTEM

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A PRELIMINARY REPORT*

THE numerous contributions dealing with blood velocity or circulation time which have appeared in the literature during the past few years have greatly increased our knowledge concerning the rate of blood flow in man. Attention has been focused on this factor as it is related to the function of the heart and the thyroid gland, to polycythemia,[1, 2] to pituitary states[3] and to other pathological conditions. In addition, such generalized reactions as those produced by exercise[4] and artificial fever[5, 6] have been studied.

The methods previously described have not lent themselves to the determination of the circulation time to the various extremities. As a result, the use of this approach to the study of vascular impairment of the extremities has not, to our knowledge, been seriously considered. An ionization method recently described by McCracken, Sheard and Essex[7] may prove to be suitable for such studies, but it requires elaborate apparatus and is strictly a laboratory procedure. Calcium chloride[8, 9] has been used for the determination of circulation time from the elbow to the throat but was not widely used because of the danger of slough at the site of injection and the lack of satisfactory response in some patients. Careful observations of the reactions at the tips of the extremities were not emphasized, although all workers using calcium compounds intravenously are familiar with such reactions.

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The possibility of such a method was the incentive for the work herein reported.

It seems essential that the following conditions should be met in order to justify the use of any agent for intravenous circulation time studies.

1. The substance must be nontoxic in the dosage employed and, if possible, totally innocuous to the body or any of its parts.

2. The reaction evoked must be definite in both normal and pathological conditions.

3. The agent should be eliminated from the system with facility, so that repeated tests may be made within reasonable periods of time without jeopardizing the welfare of the patient.

4. The method should not influence the velocity of the circulation, at least until after the desired reaction has occurred.

5. The procedure should be technically simple.

6. It should permit the expression of normal and pathological states in terms of figures which will lend conciseness to the understanding of the conditions being studied.

The purpose of this paper is the presentation of an agent which, in our opinion, fulfills the above requirements, together with preliminary studies of its use in normal and pathological states.

Preparation of the Agent.—A solution containing 42 gm. of magnesium sulphate, 16 gm. of calcium gluconate, 0.9 gm. sodium chloride, and 1 mg. of copper sulphate in 100 c.c. of distilled water is prepared. This solution must be prepared carefully, as the calcium gluconate is in proportion, in a supersaturated solution. In order to obtain a state of supersaturation, the calcium gluconate must be fresh and free from any hygroscopic water. The calcium gluconate is added to the water in a partial vacuum with the water at the boiling point. When all of the calcium gluconate has entered into solution, the sodium chloride and copper sulphate are then added. Finally, the magnesium sulphate is added, and the solution is filtered through a double layer of filter paper which has been moistened with distilled water. The solution should, at this point, be crystal clear. It is placed in a sealed container and subjected for seventy-two hours to 12° C. temperature. At the end of this time, it is again filtered and measured, and any deficiency in volume is made up by the addition of distilled water. It is then autoclaved, according to the standard technic, and, after it has been removed from the autoclave, samples are taken to check on the hydrogen ion concentration.

In our experience with the use of hard glass containers, the pH of this solution tends to drop. It has been helpful to use a soft glass container to maintain a pH of 5.5 or higher, but if autoclaving reduces the pH below 5.5, it can be buffered with sodium phosphate or sodium

citrate. The only reactions we have observed following the use of this solution have occurred when it has been injected while at a pH of 3.5 or less.

Toxicity.—Meltzer and Lucas[10] in 1907 reported that magnesium salts, when injected hypodermically or intravenously, are highly toxic. They depress the heart muscle and the central and peripheral nervous systems. The daily requirements of magnesium are estimated at 0.6 gm. The ordinary diet contains 0.192 to 1.2 gm. (Sherman, Mettler and Sinclair,[11] 1910).

After absorption or with parenteral administration of small doses, the excretion of magnesium occurs practically exclusively through the kidneys, only a small part being excreted through the large intestine. Jacoby,[12] on the other hand, claims that, in the human subject, after parenteral injection of very large doses of magnesium against tetanus, the greater part is excreted by the intestines, although its concentration in the urine exceeds that of calcium.

The toxicity of the magnesium solution is probably an ionic action. It is thought that the ionic activity may be exerted only on the surface of the cell, especially by altering the permeability of the plasmic membrane and that the antitoxic actions also affect mainly the permeability.

The high resistance of cells to the penetration of ions makes any internal effects improbable. W. Straub[13] in 1912 demonstrated that calcium acts strictly upon the cell membranes. The promptness by which the effects can be removed by the addition of a second salt also speaks against absorption. It is very probable that the single salt solutions disturb the semipermeability of the membranes (J. Loeb, 1914[14]), thus interfering with the maintenance of the electric potential which determines irritability. Increased permeability would also produce chemical changes by permitting the entrance of foreign ions. The increase of either calcium or magnesium depressed the muscle and nervous structures. The effects of magnesium may, nevertheless, be removed by the addition of calcium. Calcium also antagonizes the inhibitory effects of potassium as well as the stimulant effects of sodium (Meltzer and Auer, 1908[15]). Even more complex relations were discovered by Joseph and Meltzer[16] in 1910. Injection of magnesium into the lymph sac produces a curare action, paralyzing the muscle nerve endings, but not the muscle. The excitability is restored by calcium. Perfusion of magnesium paralyzes the muscle as well as the endings. Calcium, by itself, then, has no restorative effect. Sodium restores only the muscle. Sodium plus calcium restores also the endings. Tadokoro[17] in 1918 asserted that the velocity of calcium ions through colloids is increased by the presence of magnesium salts, whereas the diffusion of magnesium ion is retarded by calcium salts. On the other hand, the diffusion of glucose through the cells is favored by calcium and retarded by magnesium.

The solution with which we are dealing is a true ionic solution; peculiar to ions, especially the ions with which we are dealing, is their antitoxic action. This antitoxic action must not be confused with the bacteriological meaning of the same expression. Loeb[18] and Meltzer and Auer[15] clearly showed that the toxicity of an electrolite can be very greatly lessened by the addition of another suitable electrolite, sometimes in a very small proportion. The mechanism of this antitoxic action has been explained at various times in various ways. Stewart,[19] in 1902, suggested that it might be explained in some cases by alteration of permeability preventing osmotic changes or the penetration of harmful ions. This work was confirmed by Loeb[18, 20] in his work on balanced salt ratios.

Mathews[21] attempted to show that the cations and anions are both concerned in the toxic and antitoxic actions and that the valency had no direct connection with either action. Although, however, the mechanism of this phenomenon is not clear, and no theory has ever fully explained it, it is known that calcium is especially and peculiarly antitoxic to magnesium.

The solution herein presented is not a balanced salt solution in the usual sense. It is balanced only in terms of its ionic toxicity. The calcium that this solution contains is present solely for its antitoxic action on the magnesium ions. Its principal purpose is not to reinforce the stimulus produced, although it may contribute in a minor way in this regard. Magnesium sulphate reacts to form a precipitate with most calcium salts and especially with those that are appreciably soluble. We have attempted to use calcium chloride, calcium sulphate, calcium levulinate, and calcium dextrinate, but have found calcium gluconate to be the most satisfactory. In our experience, this solution herein presented is nontoxic and does not give evidence of changing the heart rate, the blood pressure or the circulation time until after the limited and fleeting reaction we desire has passed. We have repeated this test frequently in the same individual without any deleterious effect.

The copper sulphate is used in this solution as a preservative against spores and molds. Molds are difficult contaminations to control, and, unless the solution is prepared and preserved immediately in ampules according to the technic for ampule preservation of the U.S.P. XI, spores are also common contaminating organisms. The present formula represents the eighty-seventh with which we have experimented, either chemically or biologically, and, hence, we term it Formula No. 87.

Technic of Administration.—The technic of administration is similar to that used for most intravenous circulation time tests. Two cubic centimeters of this solution is drawn up in a syringe that has been fitted with an 18 gauge intravenous needle. This solution is injected quickly and easily into the antecubital vein. The time is taken from the commence-

ment of the injection, because the response may come with a minimal amount of the drug, and because the time of injection is so short for such a small amount of solution (average: ⅖ to ⅘ sec.).

Technic of Recording Results.—Before the procedure has been started, the patient is informed that something is to be injected into the vein, that a definite sensation of heat will sweep over the body in less than a minute, and that he must observe carefully and not become confused. He is instructed to report immediately the site of sensation, as follows: "tongue," "perineum" (we usually have him use the word "crotch," because it is much shorter and less technical), "right hand," "left hand," "right foot," "left foot." If the order of sequence is changed, the patient, naturally, varies the order of report accordingly. The sensations may be present elsewhere in the body, but we have concentrated on the times to the above mentioned points. Stop watch times have been doubly checked in the series of tests we are reporting.

Usually, a mild spasm of the platysma and sternocleidomastoid can be observed immediately before the patient reports the sensation in the tongue. Occasionally, the confusion of the rapid action renders the first test unsatisfactory, but, once the patient has experienced the sensation, less difficulty is met with in the second attempt. We have repeated injections within ten minutes without any deleterious effect.

Side Actions.—In more than two hundred fifty injections with this material, we have had only one case of mild thrombosis of a vein. We have had no instances of sloughing. Early in our investigation, before the hydrogen ion concentration of the solution had been rechecked, after autoclaving, several subjects reported additional mild reactions from the use of this solution. These reactions took the form of chilly sensations recurring for periods up to eight hours. On checking the solution, however, we found that the hydrogen ion concentration was at 3.5 or less, and, since this has been rectified, we have had no such experience.

RESULTS

The results presented below must be regarded as preliminary studies only. With the possible exception of the normal group, the figures are based on series too small to draw conclusions from. They are, however, interesting, and further work, to be published later, appears to confirm them generally. Table I contains all of the essential statistics. Certain points need clarification or emphasis. Six anatomical regions, namely, the tongue and throat, the perineum, the right and left hands and the right and left feet, were selected for this study. As may be seen, 40 tests were run (35 different subjects) on so-called "normal" individuals under forty-five years of age. The average figures, together with the range and the average deviations, are noted. We have used the term "blanks" to indicate tests in which no sensation was reported by

the patient in a given area. We have modified our solution since the beginning of this work, with the result that the number of "blanks" has been reduced. It is significant that, whereas, with the confusion of the first reaction, the patient may forget to report all areas, repetition in "normals" results in the reduction of the number of "blanks" to a

TABLE I

CIRCULATION TIMES*

	TONGUE THROAT	PERINEUM	RIGHT HAND	LEFT HAND	RIGHT FOOT	LEFT FOOT
Normals						
40 tests						
Average time	14.6	21.5	25.72	26.61	27.24	28.59
Range	7-22	12-32	11-43	17-43	10-46	13-48
Average dev.	±3.23	±4.588	±5.56	±4.963	±6.99	±7.235
Blanks†	0	6 tests	4 tests	9 tests	10 tests	12 tests
Vascular Disease						
Raynaud's syndrome spasm						
5 tests						
Average time	14.4	20.5	26.8	25.6	32.0	32.0
Range	12-17	12-27	21-31	21-29	29-34	29-34
Blanks	0	1 test	0	1 test	1 test	1 test
T. A. O. Organic						
9 tests						
Average time	15.22	29.33	29.42	29.0	34.5	34.75
Range	8-21	20-40	16-47	16-47	27-42	27-43
Blanks	0	2 tests	2 tests	2 tests	4 tests	4 tests
Arteriosclerosis Organic						
8 tests						
Average time	19.12	27.14	31.6	31.0	-	-
Range	14-28	20-36	20-44	20-44	28 & 44	28 & 59
Blanks	0	1 test	3 tests	3 tests	6 tests	6 tests
Hyperthyroidism						
5 tests						
A. Preoperative						
Average time	9.2	14.0	22.5	21.3	20.8	19.7
Range	8-11	11-17	16-30	16-30	15-26	15-26
Blanks	0	0	1 test	2 tests	0	1 test
B. Postoperative‡						
Average time	15.6	21.2	31.0	31.8	28.0	28.0
Range	14-17	19-24	26-36	26-36	22-31	23-32
Blanks	0	0	0	0	0	0

*Time in seconds. Method of Spier, Wright, Saylor.

†No sensation in area.

‡One patient received x-ray therapy. The results were essentially the same as postoperative.

very small percentage. The persistently poor reactors may be patients with early vascular impairment, although we have accepted as "normals" only those in whom we could find no evidence of vascular damage. All tests were taken at rest. Whether the patient sat up or was lying supine did not seem to affect the figures, so long as the injected arm was at the heart level. It will be seen that the normal figures for arm-to-

tongue circulation coincide closely with those of other methods, although the range is somewhat wider. The figures to other areas are submitted as new and preliminary leads, but not as standards, because of the limited series reported at this time.

Study of the other figures, dealing with the small group suffering from the Raynaud's syndrome in which spasm is a marked factor, shows essentially no deviation from the normal, except that the figures for the times to the feet are increased. It is interesting that the one patient who gave no reactions in the perineum, left hand, and both feet had advanced, generalized sclerodermal changes. It was to be expected that these patients with spastic, but slight if any, organic change would show a fairly normal response when not in a spastic phase. We are at present trying to compare the reactions in the spastic phase as against those in the dilated phase.

In considering the organic diseases of the vascular tree (thrombo-angiitis obliterans and arteriosclerosis), we note definite increases in the average circulation times, as compared with the normals. In the thrombo-angiitis obliterans cases, the tongue and throat figure is increased, but this might well be within possible normal limits, considering the small series. It should be noted that the percentage of blank tests is increased and, in these cases, repetition of the test did not produce the sensation, as it frequently did in normals. An analysis of these cases showed that the figures were not dependent on the patency of the major vessels alone but that good collateral vessels would permit the passage of the substance rapidly. In general, the extremities with apparently the poorest circulation were the ones with the slowest times, or "blanks." In several instances, however, we were surprised by the reaction; this fact draws attention to the possibility that we may be dealing with a new method of value in studying the circulatory system as a whole. In one patient who had no reaction in the right foot, on repeated tests, we were able to get a definite though somewhat slow reaction after improvement following treatment.

The overlapping of the figures into the normal zone is readily explainable by the fact that, while thrombo-angiitis obliterans should be considered a generalized disease, it does not involve all areas equally and at the same time.

The figures obtained by the study of the arteriosclerotic group appear of especial interest. For this test, we selected only patients whose sclerosis was advanced, as determined by study in the Vascular Clinic. As will be noted, the averages are all markedly prolonged, but, in addition, the percentage of "blanks" shows a great increase. For example, in the right foot, in normals, the original figures were 10 blanks in 40 tests, or 25 per cent. In five instances repetition resulted in sensation. In the arteriosclerotic group, however, no sensation was felt in 6 out of

8 tests, or 80 per cent, and in no instance did repetition produce sensation. The increased time to the perineum in both thrombo-angiitis obliterans and sclerosis is of interest and worthy of further study.

The figures for hyperthyroidism are included merely to point out that the circulation time in this condition is decreased, when measured by this method, just as it is by other methods. Postoperatively, as may be noted, there is a definite prolongation of the circulation time.

DISCUSSION

No attempt has been made to survey completely the literature. This has recently been well done by Fishberg.[22] It should be stressed that, in most of the so-called circulation time tests, thus far devised, the "circulation time" is, in reality, circulation time plus reaction time. This is true of our test and may play an important part in the reaction times of arteriosclerotic patients. It also rendered tests of this type unsatisfactory for study of patients who are not mentally acute.

The ether circulation test of Hitzig[23] obviates the reaction time factor but will never be suitable for studies except from the cubital vein to the lung. The ionization method[7] is too complicated for widespread use, although it should give us the most accurate figures possible.

A death has been reported directly following a decholin test,[3] and also after the injection of saccharin followed by ether.[24] In addition, numerous severe reactions have occurred following each of these methods. Thus far, in more than two hundred fifty injections, we have had only the mild reactions noted above, when, following autoclaving, the pH of our solution dropped too low. Since correcting this factor, we have had no reactions except to the degree essential for the test.

The explanation of the "blanks" or lack of reaction in certain areas is not clear at present. Blood must reach them, or the tissues could no longer live. It is our feeling that "blanks" on the first test have slight significance, but, if persistent on repeated tests, it seems as though the blood travels so slowly that the solution is too dilute by the time it reaches the area to produce the sensation. Where the sensation is produced is also somewhat questionable. It is thought to be at the neuromuscular junction but perhaps occurs at the nerve endings of the skin.

In some instances, the sensations "repeat" throughout the body several times during the ten minutes after the injection. Why this occurs in certain individuals and not in others, when the same amount of solution is injected, is difficult to say at present.

We have been constantly improving our solution during the course of this study, although the fundamental constituents have remained the same. The formula herein presented is the most recent and the most satisfactory thus far produced, but it may not prove to be the ultimate. We are presenting our work in this preliminary form to stimulate

further studies along the lines of this somewhat different approach to the study of the circulation time to various points throughout the vascular system.

SUMMARY

1. The chemical formula and the method of preparation of a new solution for the study of the circulation time to various points throughout the vascular tree are presented. We have designated it Circulation Time Test Formula No. 87, or C.T.T. No. 87.

2. The technic of administration and of recording results is outlined.

3. Normal figures for the circulation time to the tongue and throat, perineum, right and left hands, and right and left feet are presented.

4. Figures on a small series of patients with the Raynaud's syndrome show no marked deviation from normal except that the time to the feet is prolonged.

5. Figures on a small series of patients with thrombo-angiitis obliterans show a tendency to a more prolonged circulation time than that of normals.

6. Figures on a small series of patients with arteriosclerosis show a tendency to a more prolonged circulation time than that of normals.

7. Figures on a series of patients with hyperthyroidism showed a definite decrease in the circulation time, with this method as with others previously reported. The circulation time is prolonged after thyroidectomy.

8. This paper represents a preliminary study and will be followed by a more detailed paper, covering work now in progress.

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THROMBOANGIITIS OBLITERANS OF THE CORONARY ARTERIES AND ITS RELATION TO ARTERIOSCLEROSIS*

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THROMBOANGIITIS obliterans (Buerger's disease) is recognized clinically and anatomically as a characteristic entity, particularly in its early stages. Besides the vessels of the extremities, this disease occasionally involves the abdominal branches of the aorta and the vessels at the base of the brain. To judge from the relevant literature, patients afflicted with this disease of the peripheral vessels sometimes reveal cardiac symptoms and, though rarely, may die unexpectedly from myocardial failure. Autopsy reports of such instances are rare. Almost invariably the gross and microscopic examination of the coronary arteries reveals arteriosclerosis with narrowing or closure of the lumen of the coronary arteries or a coronary thrombus. The myocardium often shows fibrosis or an infarct. Only very rarely are instances encountered in the literature in which the coronary lesions were interpreted as thromboangiitis obliterans. A critical analysis of these rare cases, however, does not corroborate the diagnosis, either because the description of the relevant lesions was not clear enough and no illustrations were included or because the lesions of the coronary arteries, although sclerotic in type, were interpreted as having been the result of a previous thromboangiitis obliterans. The reason for this interpretation is that either the patient revealed the classical picture of thromboangiitis obliterans of the peripheral vessels or did not belong to the age group in which coronary arteriosclerosis "normally" occurs.

The purpose of this communication is to relate an instance of outspoken thromboangiitis obliterans of the coronary vessels in which the process in places was so recent that the histological picture was characteristic. In other portions the vessel disease was apparently much older and the vessel changes could easily be confused with those of arteriosclerosis. A review is also given of those cases of thromboangiitis obliterans with autopsy reports in which changes in the coronary arteries were encountered. The relation of such changes, usually arteriosclerotic in nature, to thromboangiitis obliterans is also discussed.

*From the department of Pathology of the Nelson Morris Institute, Michael Reese Hospital.
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LITERATURE

Buerger[5] in 1924 described three cases. In the first case (a twenty-eight-year-old male) the diagnosis, made on gross examination, was "thromboangiitis obliterans atherosclerosis of the coronary arteries." At the point of origin of the right coronary artery there was an atherosclerotic plaque on the posterior wall of the right sinus of Valsalva which encroached upon the lumen of the orifice of the right coronary artery. The descending branch of the left coronary artery was more or less filled with a fibrous yellowish white substance, which was adherent to the wall and divided the lumen of the vessel into two other small parts (recanalization?). The microscopic examination of the coronary vessels, however, presented the typical picture of arteriosclerosis, but nowhere was there evidence of thromboangiitis obliterans in the vessels examined. It is interesting to note that in the subsequent literature this case is often referred to as typical "thromboangiitis obliterans" of the coronary arteries, probably because of the misleading gross diagnosis.

The second case (a twenty-one-year-old male) revealed histologically a marked atheroma of the coronary arteries. The intima presented numerous raised patches. In a third instance (a forty-year-old male—Case 4) a few fatty plaques were found in the intima of the coronary arteries.

Perla[14] in 1925 described the sudden death of a forty-four-year-old male. The main left coronary artery showed an organized and canalized thrombus, completely occluding the lumen for a distance of 1.5 cm. There were also multiple scars in the myocardium. The lesion in the coronary artery was thought by the author to be caused by thromboangiitis obliterans. There were, however, no illustrations of the changes in the coronary arteries, nor was there a histological description of the coronary vessels involved. The author merely stated that the changes there resemble those seen in the arteries of the extremities.

Cserna[6] in 1926 described an instance (a thirty-six-year-old male) in which the descending branch of the left coronary artery at a distance of 3 cm. from its mouth was occluded by arteriosclerotic plaques. The wall of the right coronary artery was thickened and multiple scars were found in the myocardium. There was no histological description of the coronary vessels or of the heart.

Lemann[13] in 1928 reported thromboangiitis obliterans in a fifty-nine-year-old male. The coronary arteries showed an extreme degree of arteriosclerosis. The author stated that these vessels showed no lesions characteristic of thromboangiitis obliterans.

Goecke[10] in 1928 found no gross changes in the coronary arteries in a thirty-five-year-old male. Histologically, however, areas of thickening were found in the walls of two branches of the coronary arteries.

Dürck[8] in 1931 reported a number of instances of sudden death among which was that of a thirty-nine-year-old male with thromboangiitis obliterans of the lower extremities. There was also severe narrowing of the coronary arteries in this instance.

Brofeldt[4] in 1932 published a monograph on "necrosis of the extremities." He described a sixty-five-year-old male who had the clinical symptoms of Buerger's disease. Autopsy revealed a dilatation and degeneration of the heart with generalized arteriosclerosis and thromboangiitis obliterans of the abdominal aorta. In a fifty-six-year-old male sclerosis of the coronary vessels was found.

Jäger[11] in 1932 described three instances. In the first (a forty-eight-year-old male) the right coronary artery was almost, and the descending branch of the left coronary artery completely, occluded by "grayish tissue." Histologically the coronary arteries revealed areas of intimal thickening and fibrosis with a number of small sized blood vessels and eccentrically displaced small lumina. Between the internal elastic lamella and the organization tissue within the lumen there was a deposition of hyalin which in a few regions contained a network of elastic lamellae. Occasionally some calcification was present. In the second instance (a thirty-nine-year-old male) arteriosclerotic thickenings were found in the coronary arteries. In the third instance (a fifty-two-year-old male) an occlusion by a thickened intima of the descending branch of the right coronary artery was found.

Ehrström[9] in 1933 reported three instances of thromboangiitis obliterans with changes in the coronary arteries. In a twenty-four-year-old male the left coronary artery was obstructed by a thrombus. In a twenty-one-year-old male autopsy revealed a large myocardial infaret and obliteration of the coronary arteries in places. In a forty-seven-year-old male the left coronary artery contained an organized and canalized thrombus. The author stated that in Cases 1 and 3 it appeared quite certain that the coronary arteries had been the seat of a disease similar to that seen in the peripheral vessels in thromboangiitis obliterans.

De Blasi[3] in 1934 described in a thirty-one-year-old male a marked narrowing of the left coronary artery at a distance of 2 cm. from its mouth. Histologically this artery showed a subintimal cushion which occupied three-quarters of the lumen of the vessel. The endothelial lining appeared normal. The internal elastic lamella was delicate, but there was an interruption of its continuity in the region of the subintimal proliferation.

Birnbaum, Prinzmetal, and Connor[2] in 1934 described an instance of generalized thromboangiitis obliterans in a nineteen-year-old male. They mentioned that branches of the coronary arteries showed intimal thickening. Neither the aorta nor its major branches were involved.

TABLE I

NUMBER	AUTHOR	AGE (YR.)	SEX	LESION IN CORONARY ARTERIES	CORONARY ARTERIES INVOLVED	HEART	NOTE
1	Buerger	28	Male	Arteriosclerosis	Mouth of right coronary artery	Fibrosis	
				Thrombus	Descending branch of left coronary artery		
2		21	Male	Atheroma		Infarcts	
				Raised patches in intima	Both coronary arteries		
3		40	Male	Fatty plaques	Both coronary arteries		
4	Perla	44	Male	Organized and canalized thrombus	Left coronary artery	Multiple scars	Lesions in coronary arteries microscopically resemble those seen in the arteries of the lower extremities
5	Cserna	36	Male	Calcified plaque	Descending branch of left coronary artery	Multiple scars	
				Intimal thickening	Right coronary artery		
6	Lemann	59	Male	Arteriosclerosis	Both coronary arteries		
7	Goecke	35	Male	Intimal thickenings	Both coronary arteries		
8	Dürck	39	Male	Severe narrowing	Both coronary arteries		
9	Brofeldt	65	Male	Arteriosclerosis	Both coronary arteries	Degenerative changes	
10		56	Male	Arteriosclerosis	Both coronary arteries		
11	Jäger	48	Male	Occlusion by thrombus	Left coronary artery	Scars	
				Occlusion	Right coronary artery		
12		39	Male	Arteriosclerotic thickenings	Both coronary arteries	Scars	
13		52	Male	Intimal thickening	Descending branch of right coronary artery		

TABLE I—CONT'D

14	Ehrström	24	Male	Thrombus	Left coronary artery		"Quite certain that the coronary arteries had been the seat of a disease similar to that seen in the peripheral vessels in thromboangiitis obliterans"
15		21	Male	Obliteration	Both coronary arteries	Infarct	
16		47	Male	Thrombus	Left coronary artery	Degenerative changes	
17	de Blasi	31	Male	Narrowing	Left coronary artery	Fibrosis	
18	Birnbaum, Prinzmetal and Connor	19	Male	Intimal thickening	Both coronary arteries	Degenerative changes	
19	Averbuck and Silbert	43	Male	Thrombosis	Both coronary arteries	Infarct	
20		60	Male	Mild arteriosclerosis	Both coronary arteries		
21		42	Male	Sclerosis	Both coronary arteries		
22		42	Male	Arteriosclerosis	Both coronary arteries		
23		56	Male	Severe arteriosclerosis	Both coronary arteries		
24		44	Male	Mild arteriosclerosis	Both coronary arteries		
25		42	Male	Thrombosis	Right coronary artery	Infarcts	
26		53	Male	Occlusions	Left circumflex and anterior descending branch	Infarcts	
27		48	Male	Recent and old thrombus	Anterior descending branch	Infarcts	
28		56	Male	Occlusions	Left anterior descending and branch of right coronary artery		
29	van Dooren	38	Male	Occlusion	Descending branch of right coronary artery	Infarct	"Because of the inflammation surrounding the nerve trunks, the changes in the arteries were thought to be characteristic of thromboangiitis obliterans"
				Intimal thickening	Both coronary arteries		
				Obliteration	Arterioles		
30	Telford and Stopford	26	Male	Reduction in caliber	Both coronary arteries	"Heart muscle heavily infiltrated with blood"	The statement was made that the reduction in caliber was due to thromboangiitis obliterans.

Averbuck and Silbert[1] in 1934 reported the autopsy findings in sixteen cases of thromboangiitis obliterans. In ten instances coronary lesions were described. Coronary thrombosis was found three times. The youngest patients were forty-two years old (three). In none of these 16 cases was thromboangiitis obliterans of the coronary vessels described.

Van Dooren[7] in 1934 reported Buerger's disease involving the lower extremities in a male thirty-eight years old. Autopsy revealed a recent infarct of the heart. The walls of the right and left coronary arteries were thickened. The descending branch of the left coronary artery was cordlike without a recognizable lumen. The microscopic examination of the coronary arteries revealed an obliteration of many of the arterioles. In other portions the lumina were narrow, irregular and eccentrically placed. The thickened intima showed no signs of organization. The internal elastic membrane was very thin or absent. The nerve trunks in some of the sections were surrounded by numerous polymorphonuclear leucocytes. The author remarked that the changes in the arteries resembled those seen in arteriosclerosis and that there was no evidence of inflammation of the arteries. However, the inflammation surrounding the nerve trunks, in the author's opinion, was characteristic of thromboangiitis obliterans.

Telford and Stopford[17] in 1935 described thromboangiitis obliterans in a twenty-six-year-old male (Case 2). They mentioned that the coronary arteries were much reduced in caliber by thromboangiitis obliterans. A description of these changes, however, was not given.

The literature reviewed shows that coronary lesions were found in 30 cases of thromboangiitis obliterans in which an autopsy was performed. An analysis of these cases reveals that in a vast majority the lesions of the coronary arteries were arteriosclerotic, with or without coronary thrombosis. Perla[14] and Telford and Stopford[17] mentioned an instance of thromboangiitis obliterans of the coronary arteries. In both, however, the descriptions of the lesions of the coronary arteries or illustrations of such lesions were lacking. Neither Ehrström[9] nor van Dooren[7] described changes characteristic of thromboangiitis obliterans in the coronary arteries, though these authors referred to the occurrence of this disease and believed their cases to be characteristic.

Table I is included to summarize the changes in the coronary arteries and in the myocardium in those instances of thromboangiitis obliterans which, coming to autopsy, showed coronary lesions. The table also gives the names of the authors, and the age and sex of the patients.

The changes in the coronary vessels and the myocardium are apparent. It is interesting to note that all patients were males.

In the following report an outline is given of the clinical history and the pertinent autopsy findings of an instance of thromboangiitis obliterans involving the vessels of the lower extremities and the coronary vessels. The changes in the latter were pathognomonic.

REPORT OF CASE

Clinical Note.—A thirty-five-year-old male who was known to have had the characteristic symptoms of intermittent claudication over a period of about six years developed an upper respiratory infection from which he quickly recovered. As he was about to leave the house some time after his recovery, he suddenly collapsed and died instantaneously. At the time of the autopsy, no history could be obtained of previous ailments referable to the heart. As far as could be learned from various physicians, who at one time or another had attended the patient, the arterial blood pressure had always been normal, and there were no other abnormal findings.

Autopsy Findings.—The autopsy was confined to the lungs, heart and vessels of the lower extremities. The heart weighed about 350 gm. The valvular apparatus was intact. There were no mural thrombi. The myocardium was reddish gray and showed a number of small and large light gray dots and streaks and a few gray plaques, not exceeding 0.3 by 0.6 cm. in longest dimensions. These were largely in the anterior wall of the left ventricle but were also present in the wall of the right ventricle.

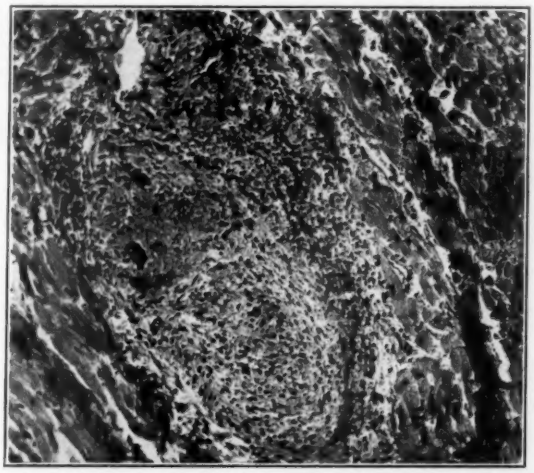

Fig. 1.—Thromboangiitis obliterans of a coronary vein. Note the resemblance to granulomatous lesions, such as tuberculosis (hematoxylin eosin preparation ×95).

The heart was dilated. The coronary arteries were markedly sclerosed and thickened by many hyalinized and calcified plaques which constricted their lumina. In various places there were also a number of atheromatous cavities and ulcers within the coronary arteries. The descending branch of the left coronary artery at a distance of about 2.5 cm. from its mouth was almost completely occluded by an intimal thickening which at one portion was covered by a reddish thrombus. The anterior and posterior tibial arteries also showed gross evidence of severe arteriosclerosis, their lumens being occluded at various places by old thrombi.

The nature of the disease of the coronary arteries was disclosed by the histological examination.

Histologic Examination.—Sections which were taken through the larger branches of the coronary arteries at points of narrowing showed various types of lesions. Some of the arteries revealed a marked intimal proliferation with much hyalinization and fibrosis. Other arteries showed just beneath the fibrosed intima atheromatous cavities containing many large histiocytic cells, the cytoplasm of which was filled with minute fat globules. There were also present typical cholesterol slits in a

network of a necrotic material. The media showed no changes of note, and the adventitia was slightly thickened. When serial sections were cut from the regions of the atheromatous cavities, a few fields were encountered showing infiltration of polymorphonuclear leucocytes with a few lymphocytes and occasional giant cells, the nuclei of which were distributed throughout the cytoplasm. These foci were found

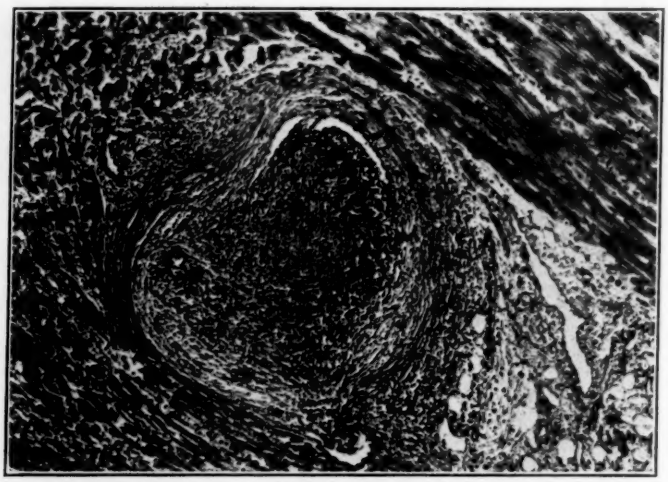

Fig. 2.—Thromboangiitis obliterans of a branch of a coronary artery. Note the rich granulation tissue forming the thrombus and the periarteritis (van Gieson preparation, ×95).

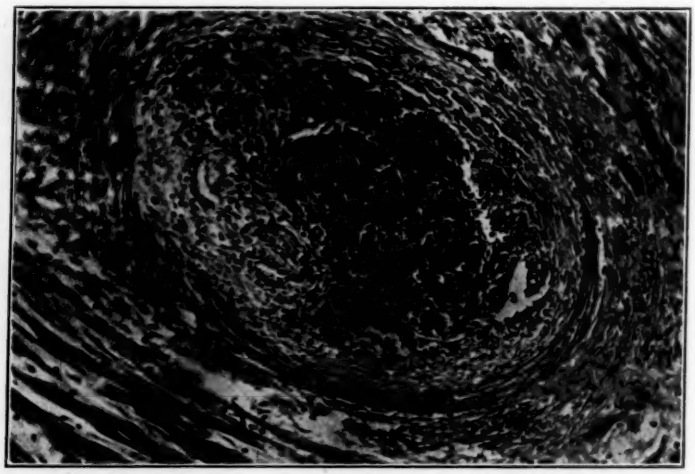

Fig. 3.—Thromboangiitis obliterans of a branch of a coronary artery. Note the giant cells within the thrombus (van Gieson preparation, ×95).

within and covering the intima adjacent to the atheromatous cavities but were also seen covering atheromatous ulcers. Other sections of the coronary arteries showed a more or less circumscribed intimal fibrosis with only a few cellular elements. Capping these lesions were a number of polymorphonuclear leucocytes and several giant cells. The giant cells were surrounded by histiocytic cells and a number of polymorphonuclear leucocytes. Much fibrin was also seen adjacent to the giant cell foci.

The adventitia in this region was considerably fibrosed and infiltrated by a few lymphocytes. Sections which were taken from the smaller coronary vessels also revealed severe changes. On superficial examination some of the vessels could not be recognized as such without the aid of an elastic stain. At the first glance the lesions in question appeared to be granulomatous in nature, surrounded by fibrous capsules. The fibrous capsules, however, proved to contain some elastic fibers, and further sections revealed that what had appeared to be a granuloma was a thrombus, completely occluding the blood vessel. Both arteries and veins were involved. The thrombus consisted of a number of polymorphonuclear leucocytes, lymphocytes, a few endothelial cells and several giant cells, many of which were surrounded by fibrin and polymorphonuclear leucocytes. Many young connective tissue cells extended from the walls of the vessels into the lumina. Some of the sections showed a new formation of blood capillaries extending into the thrombus. Often the thrombotic material occluded the vessels, while in other vessels only a minute slitlike opening forming a channel for the passage of blood could be made out. The intima of these vessels was only slightly thickened. The media showed an infiltration of lympho-

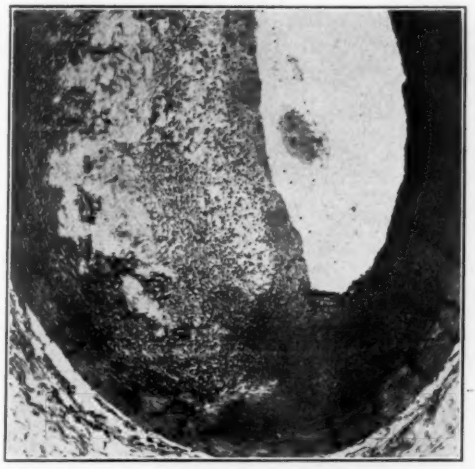

Fig. 4.—Arteriosclerosis with atheromatous cavity (hematoxylin eosin preparation, ×50).

cytes and polymorphonuclear leucocytes. Also the adventitia was infiltrated with a similar type of cell and showed varying degrees of fibrosis. In other sections the giant cells predominated. Because of the fact that the entire wall of the vessel in some of the sections was infiltrated by inflammatory cells it was difficult, at first, to recognize the lesion in question as a thrombosed vessel. On section some of the smaller vessels showed minute emboli consisting of cells similar to those which were found in the proximal part of the vessels. The walls of these smaller vessels appeared normal.

Sections of myocardium showed large areas of fibrosis separating the muscle fibers from one another. In some of the sections only minute islets of muscle fibers were found completely surrounded by dense connective tissue. The latter was poor in nuclei. In other fields newly formed connective tissue with fibroblastic cells and endothelial cells was seen, the cytoplasm of these cells containing small pigment granules. These areas could easily be interpreted as small infarcts.

Because of the fact that some of the lesions encountered were obviously very early, it was thought that an extensive search for microorganisms might reveal the causative agents. A number of sections were stained according to the Gram-Weigert and

Giemsa methods, and various silver stains were used for the demonstration of spirochetes. None of these sections, however, revealed microorganisms.

The peripheral blood vessels showed the characteristic picture of arteriosclerosis in some instances, and in others of thromboangiitis obliterans with many organized

Fig. 5.—Note the thrombus with giant cells and the atheromatous cavity in the lower right of the picture (iron hematoxylin eosin preparation, ×50).

Fig. 6.—Same as Fig. 5. Higher magnification. Note the giant cells in the thrombus (iron hematoxylin eosin preparation, ×190).

and organizing thrombi. Some of the latter contained polymorphonuclear leucocytes, fibrin, and a number of miliary giant cell foci. The perivascular spaces revealed much connective tissue uniting arteries and veins.

Summary.—A thirty-five-year-old male, who for the preceding six years had occasional symptoms of Buerger's disease confined to the lower extremities, died sud-

denly following a "grip infection." The autopsy revealed severe thromboangiitis obliterans of the coronary vessels and vessels of the lower extremities, in addition to arteriosclerosis. The myocardium showed a diffuse fibrosis with multiple old and organizing infarcts.

DISCUSSION

This case is interesting in several respects. The abruptness of the death without apparent premonitory symptoms is remarkable. Equally remarkable is the fact that the patient survived as long as he did in view of the very severe changes in the coronary vessels and myocardium. The lesions in the coronary vessels were characteristic of thromboangiitis obliterans.

After the histological findings were evaluated, a further investigation of the clinical history revealed a few additional facts which, retrospectively, in view of the anatomical findings, seemed significant. The paternal grandfather of the patient and his father's brother died of coronary thrombosis. The patient's father suffered from attacks of angina pectoris. In response to repeated questioning after the autopsy, the relatives denied that the patient had ever had attacks of substernal pain or dyspnea, but the following facts were brought out: Whenever the patient was confronted with minor physical strain, he had attacks of profuse sweating. It was recalled that on occasions when the patient had to raise his arms to hang a picture, this exertion was accompanied by sweating and such severe fatigue that he was forced to rest. None of these attacks were accompanied by dyspnea or pains of any type. In the light of the autopsy findings, it seems probable that these slight attacks of perspiration and weakness of the arms can be linked with the coronary disease and the myocardial changes and may possibly be interpreted as "abortive angina pectoris." As far as the anatomical findings in angina pectoris are concerned, it was concluded from a previous study (Saphir and coworkers[16]) that angina pectoris may be linked with a labile myocardium which may fail suddenly. To the morphologist, as a rule, coronary sclerosis and myocardial fibrosis, or as in this instance, thromboangiitis obliterans of the coronary arteries with resulting myocardial changes are the anatomical entities by means of which a diagnosis of labile myocardium may be made. In other words, the severe myocardial changes found in this heart could easily have been the cause of anginal or anginoid attacks of which the patient was scarcely conscious. The severity and extensiveness of the myocardial changes resulting from the thromboangiitis obliterans of the coronary vessels may in part also be explained by the relative youth of the patient and undeveloped collateral circulation of the coronary arteries. The final cause of death was a small thrombus in the descending branch of the left coronary artery.

As was stated above, cases of thromboangiitis obliterans of the coronary arteries are very rare. With the exception of two instances re-

ported by Perla[14] and by Telford and Stopford,[17] who mentioned thromboangiitis of the coronary arteries but who neither described nor illustrated such lesions, they have, as far as I have been able to find, not been described. Because of the fact that some of the lesions in this instance were acute and therefore, according to Buerger,[5] specific, this diagnosis could easily be made on microscopic examination. The acute inflammation of the adventitia, media, and intima, the miliary lesions consisting of polymorphonuclear leucocytes, histiocytic cells and giant cells, the lesions which at first glance may easily be confused with miliary tubercles or gummas, which, however, were shown to be within the blood vessels, constituting a thrombus, were unmistakable.

In addition to these lesions, however, other changes were encountered which were interpreted as arteriosclerotic in nature. Plain intimal thickenings with reduplication of the internal elastic layer and the formation of atheromatous cavities were significant in this respect. Occasionally, however, apparent transitions from thromboangiitis obliterans to arteriosclerosis were observed, thus rendering it difficult to differentiate between a thrombus arising on an atheromatous basis and a later stage of thromboangiitis obliterans, when organization of the thrombus has taken place. Occasionally the presence of a few giant cells in the latter revealed the true nature of the disease. The question arises as to whether the arteriosclerosis of the coronary arteries is a coincidental occurrence in no way related to thromboangiitis obliterans, whether the coronary sclerosis is merely a different stage (end stage) of thromboangiitis obliterans, or whether the coronary sclerosis developed as an entirely different entity on the basis of thromboangiitis obliterans.

Lemann[13] has raised the question as to whether or not it is a coincidence that coronary occlusion should be found in four out of five autopsies on victims of thromboangiitis obliterans. Buerger[5] stated that thromboangiitis obliterans and arteriosclerosis may be associated. Though not likely a concurrence without cause and effect relation, the simultaneous occurrence of these two diseases of the coronary arteries in older patients can never be ruled out as coincidence.

It is obvious that in early and late stages characteristic differences exist between thromboangiitis obliterans and arteriosclerosis. The region of the organized thrombus in the former disease is almost completely devoid of elastic tissue, whereas elastic lamellae are found in arteriosclerosis (Buerger[5]). The reduplication of the internal elastic lamella is also characteristic of the latter disease. However, Buerger[5] mentioned that where the lesion of thromboangiitis obliterans is of long duration (years) secondary thickening of the intima takes place with corresponding proliferation of the elastic fibers that can be confused with arteriosclerosis. Jäger[11] also maintained that in late stages a differentiation between these two diseases is hardly possible. In this instance a number of arteries showed occluding or partially occluding lesions which con-

sisted of old connective tissue with or without hyalinization; there was no new formation of elastic fibers. Here and there an occasional phagocytic cell with pigment granules in its cytoplasm was encountered. Other vessels revealed more circumscribed intimal thickenings with hyalinization, which thickenings were identical histologically with early arteriosclerotic lesions. However, when more sections were studied, minute vessels or blood pigment granules were occasionally encountered in the seemingly hyalinized region. These changes, which were found particularly in the smaller branches of the coronary arteries easily, may be interpreted as end stages of thromboangiitis obliterans. Some of the large branches of the coronary arteries, however, revealed obvious atheromatous cavities at the border between the intima and media with fat-containing cells and cholesterol slits. Some of these atheromatous cavities had perforated, thus producing atheromatous ulcers. The intima close to the atheromatous cavities and, in some instances, the recent thrombus covering the atheromatous ulcers revealed miliary lesions with polymorphonuclear leucocytes and giant cells, typical of thromboangiitis obliterans. In other words, the characteristics of arteriosclerosis and thromboangiitis obliterans were found in a single lesion. The age of the patient and the fact that in other vessels thromboangiitis obliterans predominated suggest the possibility that the thromboangiitis obliterans produced the initial changes which resulted in arteriosclerosis and atheromatosis. It seems quite clear that in older instances, changes which in their earlier stages were specific for thromboangiitis obliterans became less and less characteristic, and only fibrosis and hyalinization remained. These lesions, however, apparently formed the basis of the arteriosclerosis. Occasionally the causative agent of thromboangiitis obliterans apparently persisted, thus explaining the giant cell foci in the region of the atheromatous ulcer. It is, therefore, quite possible that true arteriosclerosis developed secondarily on the primarily diseased vessel. In a previous study[15] it was shown that arteriosclerotic lesions developed secondarily on a primary syphilitic arteritis. Karsner[12] stated, "It is conceivable that the changes (periarteritis in the coronaries of young rheumatic fever patients) might subsequently become transformed to those of coronary sclerosis." From this it would seem quite possible that the severe arteriosclerosis developed secondarily on the basis of the primary thromboangiitis obliterans. Arteriosclerosis is also often found in peripheral arteries which are the seat of thromboangiitis obliterans. It is also quite significant in this respect that there are reported in the literature a number of instances of thromboangiitis obliterans of the peripheral vessels, occurring in relatively young individuals with severe coronary arteriosclerosis. Naturally, many of these reports are purely clinical. The review of the literature, however, reveals that coronary arteriosclerosis was found at autopsy in 12 out of 30 hearts of patients who died before the age of forty years; one of these

died at the age of nineteen years; five between twenty and thirty years, and six between thirty and forty years. The high incidence of coronary arteriosclerosis in this age group is significant and points to a distinct relationship between thromboangiitis obliterans and coronary arteriosclerosis and probably arteriosclerosis in general. The fact that syphilitic and rheumatic lesions and also thromboangiitis obliterans can be the primary lesions underlying a later developing arteriosclerosis is additional evidence for primary inflammation as at least one etiological factor in arteriosclerosis.

SUMMARY

The literature dealing with changes in the coronary arteries as shown by post-mortem examinations of instances of Buerger's disease is reviewed, and thirty such cases are recorded. The lesions in the coronary arteries vary from simple intimal thickenings to severe arteriosclerosis and coronary thrombosis. In four instances the belief was expressed that the coronary lesions were characteristic of thromboangiitis obliterans. In none of these, however, was there given a clear-cut description of the coronary lesions or illustrations showing the characteristic lesions. An instance of sudden death is reported. The patient had shown clinical evidence of Buerger's disease but no evidence of cardiac lesions. The autopsy revealed severe thromboangiitis obliterans of the coronary vessels, coronary arteriosclerosis, multiple small infarcts and fibrosis of the myocardium. Sections of the coronary arteries showed, in addition to uncomplicated lesions of thromboangiitis obliterans, a combination of thromboangiitis obliterans and arteriosclerosis. Because of these findings and because of the fact that, according to the pertinent literature, coronary arteriosclerosis was found rather frequently in relatively young patients afflicted with Buerger's disease as proved by autopsy, the question of the relation between these two diseases is discussed, and the possibility is considered that a primary inflammatory lesion of the artery may be at least one factor in the causation of arteriosclerosis. Syphilitic arteritis, rheumatic arteritis, and also thromboangiitis obliterans may each constitute the primary inflammatory factor.

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CARDIAC PSYCHOSES AND NEUROSES*

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NEUROPSYCHIATRY is a specialized but an inseparable part of internal medicine. In no branch of internal medicine are neuropsychiatric manifestations so common as in the diseases of the cardiovascular apparatus. Neurotic and psychotic symptoms frequently develop in the course of, and are causally related to, organic heart disease, the *cardiac psychoses.* On the other hand, there are a great many cases showing marked cardiac symptoms but without any primary cardiac disease, the so-called *cardiac neuroses.*

The purpose of this presentation is to discuss two types of conditions, cardiac psychoses and cardiac neuroses, with special emphasis on their most difficult aspect, that of treatment.

CARDIAC PSYCHOSES

Behavior disorders and frank psychotic reactions are fairly common in the course of organic heart disease. These vary in intensity and depend upon a number of different causes.

The behavior disorders, commonly seen, are attributable to restricted activity, imposed by cardiac disease in adults, and especially in children (Foster[1]).

The *frank psychotic* reactions occurring in the course of heart disease vary from brief periods of mild delirium to outspoken dementia. The type of reaction depends upon the prepsychotic make-up of the individual and certain exciting causes. Thus one occasionally observes, in individuals with definite constitutional predispositions, manic, depressive, paranoid, and other schizophrenic reaction types. More common and more characteristic, however, are the *organic reaction types.* The latter are characterized: (a) in the intellectual sphere, by marked fluctuation of attention, difficulty in retention and activation of memory, defects in orientation, illusions and hallucinations, and impairment of comprehension and judgment; (b) in the affective sphere, by emotional instability; and (c) in the sphere of character, change to a type of conduct foreign to the individual's natural disposition.

The symptoms most commonly observed include states of confusion with disorientation, hallucinosis, persecutory trends, and states of psychomotor excitement.

The organic reactions may overshadow the underlying constitutional tendencies and bring about a complicated clinical picture. It is to be

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stressed, however, that the organic reactions may occur in previously well-integrated average normal personalities and are usually traceable to the exciting causes.

The exciting causes (Riesman[2]) include: (a) toxic factors due to renal toxemias, acidosis, and drugs, especially digitalis. I have observed a number of cases due to excessive, and especially the combined, use of two or more of the following agents: bromides, barbiturates, amidopyrine and the opiates. (b) Disturbance of circulation resulting in anoxemia, incident to congestion and edema, and in small areas of softening, which may be unaccompanied by focal brain signs, due to arteriosclerosis, thrombosis, and embolism. (c) Reflected pain from the diseased viscus, which, according to Head,[3] is responsible for the occurrence of transient and more or less lasting psychotic episodes (mood changes, suspicions, hallucinations).

The intensity, duration and prognosis of the psychotic reaction depend upon the underlying predisposing and exciting causes. In a previously well-integrated individual, a psychotic reaction even of moderate severity, when due solely to drug intoxication, will clear up in a few days to a few weeks with proper treatment. In the same type of individual, a psychotic reaction due to renal toxemia and cerebral vascular change may be a terminal process or may result in only temporary or incomplete recovery, with frequent recurrences and chronic mental invalidism. In the individual with a psychopathic make-up, trifling exciting causes may invoke lasting psychotic episodes and the severer causes may induce severe psychotic reactions leading to fatal cardiac failure.

The *treatment* of cardiac psychotic reactions includes: (1) the removal or reduction of exciting causes. In this connection it is well to remember the sensitivity of some individuals to the various sedatives and somnifacients, the cumulative effects of bromides, and, especially, the sensitivity of some individuals to combinations of drugs such as amidopyrine and phenobarbital. Disturbances of cerebral circulation may depend upon congestive failure, which should receive attention. When occlusions of small vessels are suspected, potassium citrate early and the iodides later may prove of value in some cases. (2) Some form of regimen and psychotherapy which will depend upon the type and severity of the psychotic reaction and of the associated cardiac condition. In this connection it is well to remember the danger of self-injury resulting from delirium or emotional depression and the need of proper supervision and at times of actual restraint.

CARDIAC NEUROSES

Subjective symptoms referable to the heart are observed in one form or another in nearly all neuroses. In some neuroses the cardiac complaint is a prominent or lasting symptom; in others it may be an acces-

sory complaint or only an ephemeral occurrence. The term "cardiac neurosis" implies a series of complaints referable to the precordium or to cardiac rate or rhythm constituting the predominant part of the clinical picture of the neurosis. "Cardiac neurosis," therefore, is only a part of the total situation—the neurosis—and can hardly be understood without an understanding of the concepts of neuroses in general.

Our concept of neuroses begins with the proposition that every disease must be considered as having both a somatic and a psychic component. The two components are indivisible and should be evaluated in their relation to etiology and to the total situation (Weisenburg, Yaskin, and Pleasants[4]). Whether the disease arises as a result of structural changes in the soma, of abnormal chemisms, or of emotional conflicts or abnormal psychic tensions, a change of affect of the individual (the subjective phase) and corresponding changes in the neuromuscular, autonomo-visceral, and secretory functions (objective evidences—emotional expression) take place. The principal relay station for emotional components of the various diseases would appear to be the diencephalon (Yaskin,[5] Fetterman[6]). It is responsible for the correlation of psychic and somatic disorders, has a regulating influence upon both of the major divisions of the vegetative system and indirectly upon most of the endocrine glands, upon metabolism, and heat regulation, and receives impulses from, and sends them to, the old and new brain and the neuraxis. In primary somatic disease this center receives abnormal impulses and registers them in the viscera, especially in the abdomen, "sounding board of emotions" (James[7]) in the form of emotions. In disorders of the general chemism the center may be affected, directly or centripetally via the vegetative nervous system. In states of emotional conflict and abnormal tension this center may be influenced from the cerebral cortex and then set up impulses responsible for *secondary* changes in function and even structure of the various viscera (Alvarez,[8] Moschcowitz,[9] Weiss[10]). Viewed from this concept, the diagnosis of neurosis or psychoneurosis requires not only the absence of any *primary* somatic or chemical disease, but also at all times the finding of a satisfactory psychogenic cause.

The above two criteria for the diagnosis of minor psychoses make such a diagnosis very difficult. The coexistence of organic heart disease and neurotic symptoms is well known, and their etiological relationship is often difficult to evaluate. Even with very painstaking investigation, organic disease may not be correctly diagnosed and the cases managed as neuroses. The causes for such errors have been reviewed elsewhere (Weisenburg, Yaskin, and Pleasants;[4] Yaskin[11]). Even more difficult, however, is the finding of adequate psychogenic causes without which therapy is often futile. The chief reason for the difficulty is that our present psychopathology is definitely unsatisfactory and, when subjected to scientific criteria of proof, is not completely convincing even to the

most sympathetic observer with the objective method of thinking. However, there is general agreement that for therapeutic purposes the diagnosis of psychoneuroses and neuroses implies the absence of any primary structural or chemical disease; the existence, in the majority of cases, of a certain constitutional make-up (the predisposing causes), the occurrence of precipitating or exciting causes, and the formation of symptoms which may be in the psychic or in the physiological sphere or in both. The constitutional factors may be inherited or acquired, frequently as an integral part of the psychosexual development of the individual. The term "psychopathic personality" is intended to describe in this presentation a type of make-up, characterized by either marked swings of mood or seclusiveness, misinterpretiveness, and other schizoid trends. In the "neurotic personality" the neurosis is "built into the character" and is characterized by manifestations intermediate between normal character traits and neurotic symptoms (Jones[12]). Symptom formation results from the action of some exciting cause which may be an injury, infection, a chemical disturbance, or some emotional stress. The symptoms may continue long after the exciting cause ceases to operate, and thus represent release phenomena of the neurotic traits of the previously apparently well-integrated personality. These symptoms include either frank anxiety states or symptoms tending to avoid anxiety such as conversion, compulsive-obsessive and neurasthenic syndromes, etc. (Yaskin[5]). These symptoms may vary in severity from a slight headache, increased fatigability and irritability, to devastating visceral disturbances, intractable insomnia with marked agitation, and alarming loss of weight. The clinical manifestations frequently overshadow completely the primary constitutional factors or the immediate precipitating mechanisms.

Anxiety is the central symptom of nearly all the neuroses and psychoneuroses and is of fundamental importance in the management of cardiac neuroses. Anxiety may be defined as a form of affectivity recognized introspectively as an unpleasant affect, accompanied by a fear, without any, or without an adequate cause, and manifested objectively by abnormal changes in the neuromuscular, autonomovisceral, and secretory functions (emotional expressions). That the heart should respond to states of fear is not surprising when it is borne in mind that, like the gastrointestinal tract, this organ has a rich sympathetic and parasympathetic innervation and that the vegetative system is under the control of the central nervous system. In addition, Cannon[13] has shown that, under the influence of emotions, there is an alteration in the epinephrine content which is particularly prone to influence the accelerators of the heart.

The cardiac symptoms differ in the various *types* of neuroses and are best discussed under several headings as revealed in a recent study of 100 cases (Yaskin[14]).

Table I indicates family and personality; Table II, the precipitating causes; Table III, the modes of treatment employed; and Table IV the end-results.

TABLE I

FAMILY HISTORY AND PERSONALITY IN THIS SERIES OF 100 CASES

FAMILY HISTORY	NO. OF CASES	PERSONALITY	NO. OF CASES
Neuropathic	44	Neurotic	75
Psychopathic	16	Psychopathic	2
Negative	40	Average normal	23
Total	100	Total	100

TABLE II

THE PRECIPITATING CAUSES IN THIS SERIES OF 100 CASES

	ANXIETY NEUROSIS	CONVERSION HYSTERIA	ANXIETY HYSTERIA	COMPULSIVE-OBSESSIVE REACTIONS	OCCURRENCE IN NUMBER OF CASES
Financial reverses and economic insecurity	2	5	6	2	15
Illness and death in immediate family and of close friends	2	2	12	1	17
Marital infelicity, including infidelity		5	12		17
Other dissensions in family		3			3
Fear of criminal punishment and social ostracism to self or to members of family			4		4
Surgical menopause and other endocrine disturbances		1	2	1	4
"Old maidedness"			5		5
Abnormal attachment to certain members of family			5	5	10
Coitus interruptus and other unsatisfactory methods of contraception	4				4
Fears related to masturbation	3				3
Fears of marriage and pregnancy	1		4		5
Frigidity			8	3	11
Impotence			3		3
Incest with sisters				2	2
Homosexual trends	1		6	3	10
Anal eroticism				5	5
Sodomy				2	2
Ordinary strain of life and no satisfactory causes			9		9

CARDIAC SYMPTOMS IN THE VARIOUS TYPES OF NEUROSES AND PSYCHONEUROSES

Anxiety Neurosis.—Under this heading are included those neuroses characterized by *episodic* occurrence of anxiety, accompanied by definite somatic symptoms, and by complete or nearly complete freedom from all symptoms between attacks. Of all somatic manifestations, palpita-

tion is the most common. Its occurrence is accompanied by anxiety, trembling, and general weakness and is frequently accompanied or followed by perspiration. There were 9 cases of anxiety neurosis in the above mentioned series of 100 cases. In each of these cases palpitation with anxiety was the outstanding symptom complex. The personality make-up in anxiety neurosis is not of particularly great significance.

TABLE III

MODES OF TREATMENT IN THIS SERIES OF 100 CASES

	ANXIETY NEUROSIS	CONVERSION HYSTERIA	ANXIETY HYSTERIA	COMPULSIVE-OBSESSIVE REACTIONS	TOTAL NUMBER OF CASES
Encouragement	4	4	30	2	40
Suggestion	4	9	48	5	66
Rationalization and persuasion	3	2	10	2	17
Attempts at compromise formation		3	25	2	30
Education and reeducation			12	2	14
Partial analysis		4	15	11	30
Partial analysis with amytal narcosis				2	2
Regimen at home, at work, and change of environment other than hospitalization		2	11		13
Hospitalization			11		11
Occupational therapy			7		7
Physiotherapy			6		6
Sedative and tonic medication	5	3	43	6	57
Appropriate contraception	6				6

TABLE IV

END-RESULTS IN THIS SERIES OF 100 CASES

	ANXIETY NEUROSIS	CONVERSION HYSTERIA	ANXIETY HYSTERIA	COMPULSIVE-OBSESSIVE REACTIONS	TOTAL NUMBER OF CASES
Recovery	9	9	21	2	41
Improvement		3	30	8	41
No improvement			6	3	9
Developed psychoses			6		6
Recurrence	1	2	18	3	24

The precipitating causes are to be found in the immediate present or in the recent past and, as observed in this series, were not particularly complicated. The treatment in this group of cases is relatively simple if the causes can be removed. Inasmuch as most of the latter are to be found in the irregularities of the sexual act, the treatment consists largely in the removal of the cause, in suggestion, encouragement, and other superficial modes of psychotherapy, and in sedative medication.

The results in the majority of cases of anxiety neurosis are favorable and all cases in this series recovered, there being only one recurrence.

Conversion Hysteria.—Under this term are designated forms of psychoneuroses characterized by the presence of motor, sensory, visceral, and episodic phenomena (conversion symptoms) accompanied by little or no anxiety, not due to any physical or biochemical abnormality, and traceable to some definite psychogenic cause. Cardiac complaints are not prominent symptoms in conversion hysteria and consist of a complaint of vague precordial pains or of a statement by the patient that he has "heart disease" but unaccompanied by any overt anxiety. In 12 patients in this series, 2 complained of heart weakness, 1 of precordial pain, and 2 of "cardiac disease." As revealed in the four tables, in conversion hysteria the family history and the personality of the patient play a considerable rôle. The precipitating causes in this group of cases are usually not difficult to find, and in this series were related chiefly to marital difficulties, death in the family, or to a feeling of economic insecurity. Suggestion in some form is probably the first method of treatment to be employed in these cases. Attempts at compromise formation in marital and economic difficulties also require and deserve considerable attention. The end-result in these cases is usually good providing the cause can be removed or the patient is made to make some compromise. In this series 9 patients recovered, 3 improved, and only 2 had recurrences.

Anxiety Hysteria.—Under this term are designated conditions showing a variety of somatic complaints not due to primary organic or biochemical disturbances, accompanied by diffuse anxiety or by phobic phenomena, and traceable to psychogenic, often unconscious, causes. In anxiety hysteria cardiac complaints are fairly constant and often severe. The anxiety hysteria group comprised 63 per cent of the series of 100 cases analyzed. In these 63 cases changeability of pulse rate and frequent attacks of tachycardia were observed in 43 cases, actual dyspnea in 13, precordial discomfort in 24, dizziness and especially fear of cardiac death in 18, transient elevation in blood pressure in 17, and fear of being left alone or going out unaccompanied in 13 cases. Three of these patients had previously been subjected to subtotal thyroidectomy without any improvement of symptoms.

In this group of cases the family histories indicate a large proportion of neuropathic and psychopathic ancestry. The personality histories indicate a large neuropathic element. The predisposing causes in this group of cases are usually deep-seated, while the precipitating factors are numerous and varied. Even without a deep analysis and only by the review of the precipitating factors, it may be observed that these patients have a great deal of distortion in their psychosexual development and attitude. As is well known, the clinical course of these cases is extremely troublesome to the patient, the family, and to the physician.

In addition to numerous somatic complaints, the presence of diffuse anxiety, and numerous phobic phenomena make the management of these cases trying and require a great deal of ingenuity on the part of the physician and his aides. Eleven of this series required hospitalization because it was impossible to manage them at home. In another 11 cases a great deal of attention had to be paid to the regimen and the daily activities of the patients, which were outlined for them. Encouragement, suggestion, and hospitalization were used in a good many of the cases but these in themselves have limited value. An element which is of some importance in the treatment of these patients is an attempt at compromise formation. Especially is this true in cases of marital difficulties where the illness of the patient is probably the most important element in the marital infelicity. Sedative and tonic medication were indispensable in most of these cases. Perhaps the single most important therapeutic agent is the partial analysis, but, because of the elements of time consumption and expense and because of the resistance of a good many patients, this is not always practical. My impression is that, of all the cases, those in whom partial analyses were performed were most benefited. At the same time attention is directed to the fact that, even in those 15 cases where partial analysis was employed, other forms of treatment, especially sedative and tonic medication, were used.

In this series of 63 cases, 21 recovered, 30 improved, and 6 showed no improvement. Eighteen of the series had recurrences. Thirteen of the 21 recovered patients received a partial analysis. It is of interest to note that among the recurrences not one had received partial analysis. Six patients developed psychoses, which should make the diagnosis of anxiety hysteria guarded. Five of these six cases developed an agitated depression while one turned out to be definitely schizophrenic.

Compulsive-Obsessive Reactions (Psychasthenia of Janet).—Under this term are designated conditions characterized by the existence of irrepressible thoughts and irresistible impulses designed to avoid anxiety, by the patient's recognition of the absurdity of these thoughts and impulses, and by the appearance of anxiety when the patient attempts to "disobey" the thoughts and impulses. Palpitation and a feeling of impending death is the penalty in these patients when they attempt to disobey the irrepressible thought or impulse. There were 13 cases in the analyzed series. In this group the family history is not predominantly significant. The personality history, on the other hand, shows a very definite neuropathic trend. This becomes more evident when even a partial analysis is attempted. By this method neurotic traits are found to have existed since childhood, but were thoroughly integrated in the personality make-up, and did not produce disabling symptoms until somewhat later in life. The precipitating causes can be ascertained only by a partial analysis and then are to be found largely in the

psychosexual sphere. It is in this form of psychoneurosis that treatment other than a partial analysis is of little value. These patients do have, however, periods of anxiety, when the ordinary forms of treatment including encouragement, suggestion, and sedative medication are of definite value. For the majority, however, some attempt must be made to make them relive their early experiences. This is a long-drawn-out affair because of the inherent resistance of these patients to the necessary investigation and because of their critical attitude toward any form of treatment. Of the 13 cases in this series all received a partial analysis, two with the aid of amytal narcosis (Yaskin[15]).

Neurasthenia.—By this term is understood a relatively rare disease beginning in early life, lasting with intermissions throughout life, and characterized by abnormal mental and physical fatigability and irritability, various somatic complaints, mental depression, and insomnia. Neurasthenia as a primary disease is to be distinguished from the neurasthenic symptom-complex which is of common occurrence in many and varied somatic, endocrine, and metabolic diseases as well as in the psychoses, neuroses, and psychoneuroses. In this series there were only 3 cases, all with a neuropathic family history, and all showing temporary improvement with suitable rest regimens and living within the bounds of their physical and mental capacities. In the 3 patients analyzed, palpitation, precordial discomfort, and "heart consciousness" were found. The analysis of the cases of neurasthenia is omitted from the tables.

GENERAL COMMENT ON THE CARDIAC NEUROSES

It is evident that cardiac complaints are nearly universal in all forms of neuroses and constitute the predominant and lasting symptoms in some. The character, severity, and duration of cardiac symptoms depend upon the type of neurosis of which the cardiac symptom is only a constituent part. The type of the neurosis depends upon the various etiological factors which are responsible for the mechanism of symptom formation. In the final analysis the diagnosis and successful treatment of cardiac neurosis depend upon our ability to determine the etiological factors. This is not always easy.

The *family history and personality* (as indicated in Table I) are of some interest. The high incidence of neuropathic inheritance is in keeping with the civilian types of psychoneuroses. The incidence of the neurotic types of personality in this series is higher than is generally supposed to be the case in the psychoneuroses. An important reason for this probably is the fact that 32 of the 100 cases received a partial analysis thus making it possible to disclose the existence of neurotic traits prior to the development of the clinical manifestations.

The *precipitating causes,* as shown in Table II, are of definite importance. In keeping with the general knowledge on this subject, there are no specific etiological factors. The causative factors embrace a wide

range of economic, social, marital, and psychosexual components. In anxiety neurosis and conversion hysteria the causes are relatively superficial, while in anxiety hysteria and compulsive-obsessive reactions they are more profound and are more intimately associated with the psychosexual life. The latter observation is, however, definitely influenced by the fact that 15 of the 63 patients with anxiety hysteria and all of the 13 patients with compulsive-obsessive reactions received partial analysis while only 4 of all the remaining patients in the series of 100 were partially analyzed.

In the majority of cases in this series there is more than one precipitating cause, and it is probably true that the clinical manifestations result from the cumulative action of various factors. It is frequently impossible to evalute the importance of several existing causes. This is true even when a careful personality study is combined with an accurate chronological determination of the development of the various precipitating factors.

At times it is difficult to state whether the "precipitating cause" is really a cause or only an evidence of disease. This is particularly true of marital infelicities which are not infrequently determined by the subtle neurotic attitudes of the patient. If this be so, it is of considerable therapeutic importance, especially as it points to the necessity of attempting compromise formations. In a large proportion of the 17 cases of marital infelicity in this series, the neuroticism of the patient was the determining cause of the marital discord.

It would appear from this review that, contrary to psychoanalytical trends, ego and herd instinct motivations, as observed in economic insecurity, fears of criminal punishment and of social ostracism, "old maidedness," and similar related factors play an important rôle as precipitating causes in the psychoneuroses. On the other hand, there is a large proportion of patients in whom the disturbance of the love life undoubtedly acted as a determining cause. The shades of the disturbance varied from infidelity of a spouse to sister incest. It is particularly significant that frigidity was encountered in 11 cases and homosexual trends in 10 cases, and these occurred almost exclusively among the cases found in the anxiety hysteria and compulsive-obsessive reaction groups.

The *modes of treatment* employed, as shown in Table III, permit of no definite conclusion although there are many interesting factors. The methods employed are clinical applications and are not to be regarded necessarily as scientifically controlled procedures. They are therefore not entitled to scientific credit nor to scientific criticism. As empiric measures, their value should be judged entirely by their therapeutic success or by their failure.

A mere glance at Table III discloses that a great many methods were used in the same patient, and one unpleasantly associates this with the

old "polymorphous pharmacy." Like the latter, however, these methods have, for the present, some definite though empiric value.

Irrespective of the fundamental psychopathology, the relief of symptoms is always of importance. Some methods, such as encouragement and suggestion, are, like the stomachics and hematinics of old, of distinct benefit in the majority of cases. Encouragement was employed in 40 and suggestion in 66 of the 100 cases. These methods are intended for the removal or correction of symptoms and are particularly valuable in conversion hysteria and in most cases of anxiety hysteria. They are of limited value in some cases of anxiety hysteria and only rarely of real benefit in compulsive-obsessive reactions. Of the other methods intended for the amelioration of symptoms, regimen and hospitalization were used in 24 cases, most of which were anxiety hysterias. In some cases these methods were indispensable and, in the majority of others, of definite benefit. Along with these procedures, occupational and physical therapy proved useful. Somnifacients and sedatives were employed without hesitancy when anxiety was a prominent or acute symptom in any of the cases of this series. In the ill-nourished patients, tonics were used freely.

The remaining methods which were employed attempt to influence the underlying causes and psychopathological processes. Mention should be made that most of these methods are tinted with elements of suggestion and encouragement, a fact which need not detract from their therapeutic value.

Appropriate contraception is frequently a relatively simple and beneficial procedure, especially in anxiety neurosis.

Rationalization and persuasion, education and reeducation, all of which attempt to utilize the intellectual approach, are probably of limited value as observed in most cases in which they were used. They were employed chiefly in anxiety hysteria and perhaps were useful in preparing the patient for a partial analysis. Rationalization and persuasion are of some benefit in anxiety neurosis resulting from the fear of the consequences of masturbation.

An attempt at compromise formation is of definite benefit in suitable cases. In this procedure, the patient is carefully guided to evaluate the various situations which may have a bearing on his illness. By comparing different possible solutions in regard to their possible consequences, the patient makes a choice in accordance with the changed emotional attitude. This process is tedious but is of considerable benefit to the patient. Attempts at compromise formation have proved of definite value in some cases of marital infelicity, in situations associated with a feeling of economic insecurity, "old maidedness," fear of ostracism, and in related conditions. The great majority of cases treated by this method were anxiety hysteria.

Partial analysis is, in the author's experience, the best psychotherapeutic approach to the underlying psychopathology and etiological factors. By this method a limited exploration of the unconscious is attempted, first, through formal interviews, then, after some explanation to the patient of what is sought, by a modified free association technic. This method is not to be confused with a full psychoanalysis. It is not a complete investigation of the unconscious but, surprisingly, it is often deep enough to touch upon fundamental processes and achieve considerable benefit. It has the great advantage over complete analysis of not being so time consuming. It proved of definite benefit in most of the cases of conversion hysteria, anxiety hysteria, and compulsive-obsessive reactions in which it was used. In the last named group it is the only method (except complete psychoanalysis) that is worth attempting. In two cases each treatment was preceded by a light sodium amytal narcosis.

The end-results, as shown in Table IV, compare rather favorably with end-results of treatment in many other branches of medicine. The present review does not permit any formulation as to what determines these end-results. In general, it may be stated, however, that the outcome of the treatment is definitely influenced by the type of the neurosis and the modes of treatment.

Most recoveries were attained in the anxiety neuroses in which the causes could be effectively influenced, and least in the compulsive-obsessive reactions which are accompanied by deep, resistive psychosexual distortion. It is generally agreed that the latter are not uniformly cured even by prolonged psychoanalyses. The recoveries in conversion hysteria, treated chiefly by suggestion and encouragement, were good. The recoveries in anxiety hysteria were better than was anticipated, and the majority of the recoveries in this group were attained by partial analysis and attempts at compromise formation.

Improvement was observed chiefly in anxiety hysteria and in compulsive-obsessive reactions. In the former group the results were due to a combination of several methods among which regimen and hospitalization played a large, though not an exclusive, rôle. In the latter group the improvement was due solely to partial analysis.

The failure of improvement in 9 cases, 6 anxiety hysteria and 3 compulsive-obsessive states, is to be ascribed to the severity of the clinical condition, the failure of cooperation or actual resistance on the part of the patient, and probably, what is most important, to a lack of therapeutic acumen on the part of the physician.

Six patients developed psychoses. This probably was not due to faulty therapy, but to poor diagnostic judgement.

Recurrence was observed in 24 cases, 18 of which were anxiety hysteria. The recurrences were traceable in the majority of cases to the incidence of new or reactivated precipitating causes, and, in many instances, to inadequate treatment of the preceding attack.

SUMMARY AND CONCLUSIONS

Psychotic reactions in the course of organic heart disease vary from mild behavior disturbances to severe reactions. The type and severity of the reaction depend upon the prepsychotic personality, upon renal toxemia, acidosis, drugs, cerebral anoxemia associated with congestion, edema and small softenings, and in some cases upon enforced inactivity and reflected pain.

The term "cardiac neurosis" implies a series of complaints referable to the precordium or to cardiac rate and rhythm. These complaints are only a conspicuous part of the total neurosis. Anxiety is the central problem of all neuroses and psychoneuroses. The etiology and symptomatology of the cardiac neuroses vary with the several types of neuroses and psychoneuroses.

One hundred cases comprising anxiety neuroses, conversion hysteria, anxiety hysteria, compulsive-obsessive reactions, and neurasthenia were reviewed from the standpoint of cardiac symptoms, family history, personality, precipitating causes, modes of treatment, and end-results.

This study is an attempt to emphasize that cardiac neuroses should be managed as neuroses and psychoneuroses. As such they require comprehensive neuropsychiatric studies and utilization of various therapeutic approaches.

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THE TREATMENT AND THE IMMEDIATE PROGNOSIS OF CORONARY ARTERY THROMBOSIS (267 ATTACKS)*

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IN THIS country and abroad the mortality rate of coronary artery thrombosis is quoted generally as ranging from 35 to 65 per cent with an average of 50 per cent.[1-9] Dublin[10] has stated, "No other disease in the entire field of medicine with the possible exception of cancer offers so large an opportunity for life-saving service." Our experience leads us to believe that the mortality may be lessened by certain simple logical procedures and by the use of a low calorie diet.

Coronary artery thrombosis usually presents a characteristic picture. Occasionally, however, the differentiation from other conditions, particularly angina pectoris, is difficult. If the diagnosis is doubtful the patient should be treated as though he had suffered a coronary artery occlusion. He should be put to bed and a search patiently made for a drop in blood pressure, a change in heart sounds, alterations in the electrocardiogram, etc. These signs may not appear for a few days or longer, but within two to four days one can usually make certain whether a real closure of a coronary artery has occurred.

The data we are analyzing were collected from both private and ward patients. The number of attacks observed was 267, of which 122 occurred in 103 private patients (A.M.M.) and 145 in 140 hospital patients. No case was included unless the diagnosis of acute coronary artery occlusion was certain.

TREATMENT

It should be understood that the procedures described are for the period of the acute coronary artery thrombosis. When this diagnosis was made or suspected, the patient was put to bed immediately. Absolute quiet and rest were enjoined. In private practice day and night nurses were employed whenever possible, but hospital patients had floor nursing care only; this included being fed whenever possible. There was no hesitancy in administering as much as ¾ grain of morphine within twelve hours if pain was very severe. Practically every clinician who has studied coronary thrombosis has advocated the use of this drug. We think morphine is of help not only because it relieves pain but also

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because, as David[11] has indicated, it lightens the work of the heart by slowing the heart rate and lowering the basal metabolism. Morphine diminishes respiratory effort and tends to prevent nocturnal dyspnea and cardiac asthma as Eppinger and his coworkers,[12] Fraser,[13] and Harrison[14] have shown.

Diet.—Diet was an important part of the treatment. Very little food was given during the first few days, especially to the very sick patients. The fluids were limited to 1,000 to 1,200 c.c. unless the patient was perspiring profusely. When nausea or vomiting was present, food was withheld and small quantities of cracked ice and charged water were given. As the patient improved, the diet was slowly increased so that in from five to seven days he was receiving 750 to 850 calories. The diet was well balanced, containing approximately 100 gm. carbohydrate, 50 gm. protein, 20 gm. fat with adequate vitamins and calcium.

800 Calorie Diet

Breakfast	*Sample Menu*
100 gm. 12 per cent fruit	½ medium orange
10 gm. cereal	2 tablespoons cooked cereal
200 c.c. skimmed milk	1 cup
1 egg	1 egg
15 gm. bread	½ slice
Dinner	
60 gm. meat	2 ounces meat
100 gm. 3 per cent vegetable	½ cup spinach
100 gm. 12 per cent fruit	3 plums
15 gm. bread	½ slice
200 c.c. skimmed milk	1 cup
Supper	
1 egg	1 egg
100 gm. 3 per cent vegetable	¾ cup canned string beans
100 gm. 12 per cent fruit	1 medium peach
15 gm. bread	½ slice
200 c.c. skimmed milk	1 cup

The 800 calorie diet was maintained for at least three to six weeks and frequently for much longer periods. Obviously, adherence to the diet prescribed was necessary if any conclusions were to be drawn as to the value of this form of therapy. A patient presumably on an 800 calorie diet might actually be ingesting several hundred calories more because of a kind attendant or relative. Our procedure was explained to the patient and his family; indeed the cooperation of the latter was essential. An endeavor was made to accord each patient individual attention and to satisfy his tastes whenever possible. In only a minority of cases did the patient complain of hunger; this could usually be allayed by arranging for a small evening portion or by the addition of noncaloric candy, etc. Increasing the bulk of the food with vegetables sometimes sufficed. Although only very exceptionally did we find it necessary to increase the caloric intake in our cases, we were ready to do it if it was indicated in a particular case.

Drugs.—Digitalis, nitroglycerin, amyl nitrite, adrenalin and ephedrine were considered contraindicated. Fenn and Gilbert[15] believed that digitalis increased precordial pain. Experimentally it has been shown to be harmful, for Bellet, Johnston, and Schecter[16] found that dogs in which myocardial infarction had been produced were more susceptible to fatal digitalis poisoning.

In regard to nitroglycerin, Hadfield[17] found that by lowering diastolic blood pressure in dogs he could increase the size of the experimental infarct. Hence he, as well as Hubble[18] and also Luten,[19] concluded that nitroglycerin was dangerous in coronary occlusion. Prodger and Ayman[20] and Sprague and White[21] have cited clinical instances in which coronary thrombosis was precipitated or its course influenced fatally by nitroglycerin. Grollman[22] has proved that nitroglycerin increases the work of the heart. Riesman[23] on clinical grounds considered both digitalis and nitroglycerin dangerous.

Concerning the contraindication to the use of adrenalin, it is hardly necessary to enter into detail. Levine, Ernstone, and Jacobson[24] showed that adrenalin produced pain in patients with an anginal syndrome, and Cottrell and Wood[25] pointed out that it could cause other serious symptoms. Grollman[22] indicated that it, too, increased the work of the heart.

With congestive failure the usual measures were employed, that is, limitation of fluid and salt. We did not give digitalis but resorted to injections of mercupurin when necessary.

Cardiac arrhythmias exclusive of multiple premature beats occurred in twenty cases. These were nodal rhythm, paroxysmal tachycardia, auricular fibrillation, auricular flutter, partial and even complete heart-block. Except in one case of auricular fibrillation these severe irregularities disappeared spontaneously without any specific treatment.

No cathartics or enemas were given during the first three to five days. On the low diet described, there was rarely distention in spite of lack of bowel movement.

Oxygen therapy was utilized in thirty-five attacks occurring on the ward. In this group there were twenty-three deaths. This method of treatment was employed only in cases with cardiac failure or pulmonary complications, particularly in cases with severe dyspnea and cyanosis. It often relieves pain, dyspnea, and cyanosis. Occasionally, however, a patient was quite uncomfortable in the oxygen tent in spite of proper air conditioning and oxygen supply.

Prolonged Stay in Bed.—The patient was kept in bed from four to ten weeks, the average time being five and one-half weeks. He was then permitted gradually to get out of bed into a chair and usually by the seventh or eighth week he was able to walk. By lowering the energy required of the body, bed rest diminishes the work of the heart. Numerous writers have expressed the opinion that a stay of four to six weeks

in bed is essential. Bedford[26] and also Levine[2] have emphasized that only after the first three to six weeks does repair of the injured heart musele set in. We believe that it is equally important for the patient's future health. The patient who leaves his bed too early is more likely to develop congestive failure or to have a recurrence of a coronary thrombosis. Cooksey[8] showed that patients who were permitted out of bed too soon did not fare as well as those who remained in bed for at least six weeks. Sutton and Davis[27] have shown experimentally in dogs that the longer the rest following infarction, the firmer the scar which results. In the dogs allowed to exercise early, aneurysmal dilatation through a thin scar resulted.

RESULTS

In the 267 attacks studied by us the mortality rate in the first attack was 8 per cent (Table I). For all the attacks, it was 16.5 per cent. All deaths were included from the time of admission to discharge or,

TABLE I

MORTALITY RATE OF EACH ATTACK OF CORONARY ARTERY THROMBOSIS

	HOSPITAL	PRIVATE	MALE	FEMALE	TOTAL
1st attack	78	74	112	40	152
Deaths	8	4	9	3	12
Mortality	10%	5.4%	8%	8%	8%
2nd attack	48	37	67	18	85
Deaths	14	5	16	3	19
Mortality	29%	13.5%	24%	16.5%	22%
3rd attack	18	8	22	4	26
Deaths	8	4	9	3	12
Mortality	44%	50%	41%		46%
4th attack	2	2	2	2	4
Deaths	0	1	0	1	1
Mortality					
All attacks	145	122	203	64	267
Deaths	30	14	34	10	44
Mortality	20.7%	11%	16.7%	15.6%	16.5%*

*Excluding deaths occurring in the first 24 hours, the mortality was 11 per cent.

in the patients seen in private practice, up to the time of being permitted out of doors. If deaths occurring within twenty-four hours are excluded, the mortality rate was 11.5 per cent. Probably as a result of more prompt and meticulous medical and nursing care, the private patients fared better than those treated in the hospital. In the former the mortality rate was 5.4 per cent for the initial attack and 12 per cent for all attacks; in the latter, 10 per cent for initial attacks and 20 per cent for total (Table I). One may conclude, therefore, as Conner and Holt[3] have already pointed out, that the majority of patients survive their first coronary occlusion. Other authors, too, have indicated this; Moritz

and Beck[28] discovered at post-mortem examination that 86 per cent had survived their first occlusion. Barnes and Wade,[29] Saphir, Priest, Hamburger, and Katz,[30] Smith, Rathe, and Paul[31] found evidence of more than one coronary occlusion in the great majority of cases seen at autopsy.

The results were practically the same in men and women in all decades (Table II). In our series the ratio of men to women was three to one (Table II). Although some of the earlier reports on coronary thrombosis gave the impression that this disease is much more frequent in men, it is now evident that it is not uncommon in women. Moritz and Beck[28] in ninety-four post-mortem examinations actually found the number of men and women to be the same.

The ages of the patients studied ranged between twenty-seven and eighty-seven years (Table II). The average was fifty-four years for both men and women. The average age of those who died was fifty-seven years, which age is only slightly greater than the average age of those who recovered from attacks.

TABLE II

NUMBER OF ATTACKS OF CORONARY ARTERY THROMBOSIS IN EACH AGE GROUP

AGE IN YR.	MALE	FEMALE	TOTAL	DEATHS
27-39	15	6	21 (8%)	2 (10%)
40-49	46	16	62 (23%)	8 (13%)
50-59	70	16	86 (32%)	13 (15%)
60-69	53	18	71 (27%)	15 (21%)
70-87	19	8	27 (10%)	6 (22%)
Total	203	64	267	44

Twenty-one attacks were treated in patients under the age of forty; only two of these died. Sixty-two attacks were treated in patients between forty and forty-nine years of age, with a 13 per cent mortality. The mortality rate rose in the older age groups, reaching 22 per cent in the eighth decade. In each decade, men and women fared the same. It will be seen that coronary thrombosis is not uncommon between thirty and fifty or even between thirty and forty, as Conner and Holt[3] have pointed out, although it occurs most frequently in the sixth decade. Once more, in confirmation of these authors, our finding that the mortality rate is lowest in the young and higher in the older group does away with a more or less prevalent notion that coronary thrombosis is much more serious in the young, i. e., the fourth decade or earlier.

Multiple attacks of coronary thrombosis were surprisingly common. One hundred four (43 per cent) of our patients sustained more than one closure: there were two attacks each in 76 patients, three attacks each in 24, and four each in 4 patients, totaling 379 episodes of acute coronary artery occlusion in 243 patients, although only 267 of these attacks were treated by us. The same post-mortem evidence that was previously cited[28-31] to emphasize the fact that patients survived the

first attack of coronary thrombosis can be given to demonstrate the frequency with which multiple attacks occur. It is unusual to find evidence of only one myocardial infarct post mortem. When death occurs, proof of multiple coronary occlusion is present in nearly 80 to 90 per cent of cases.

Hypertension was present in 177 or 66 per cent of the attacks either at the time of observation or preceding the attack. If the systolic blood pressure was 150 mm. or more or the diastolic 90 mm. or more, hypertension was considered to be present. The mortality rate in these hypertensive patients was 13 per cent. In the ninety attacks without known hypertension, it was 23 per cent. Moreover, of the forty-four patients who died only 23 (52 per cent) suffered from hypertension. Thus the prognosis in our series was not directly influenced by the presence of hypertension.

The electrocardiograms were analyzed from the standpoint of localization of the infarct on the anterior or posterior surface of the heart.[32, 33*] Both the electrocardiogram and the post-mortem studies were used for this localization. In patients suffering their initial attack of myocardial infarction, the infarction occurred on the anterior surface in sixty-five and on the posterior surface in sixty-six. The mortality rate in each group was about the same, 7.5 per cent and 6 per cent, respectively. In nineteen cases there was evidence of infarction of both surfaces, and the mortality in this group was 10.5 per cent.

In patients suffering an attack subsequent to the first, the last acute infarction occurred on the anterior surface in thirty-nine with a mortality of 18 per cent and on the posterior surface in forty with a mortality of 22.5 per cent. Infarction occurred on both surfaces in twenty-five, the mortality rate rising to 44 per cent. Hence, the frequency of anterior and posterior infarctions was about the same and mortality rate identical.

DISCUSSION OF THE UNDERNUTRITION THERAPY

We believe that the undernutrition therapy[34-37] has been a factor in the good results we are reporting, and we shall endeavor to give evidence to support this view.

During the two periods, 1930 to 1932 and 1933 to June, 1934, the mortality rate of ward patients at the Mount Sinai Hospital, New York, was 39.7 per cent and 40.5 per cent, respectively, whereas since June, 1934, under our method of treatment it has been only 20.7 per cent (Table III). Excluding deaths occurring in the first twenty-four hours, the mortality rate has been halved, i.e., from 33 per cent to 16 per cent,

*R-T elevation, T-wave inversion and a large Q-wave in Lead I or Leads I and II, and R-T depression, upright T-wave, and absent Q-wave in Lead IV were evidences of infarction of the anterior surface of the left ventricle. R-T transition elevation, inversion of the T-wave and large Q-wave in Lead III or Leads II and III, and elevation of the R-T and upright T-wave in Lead IV were evidences of infarction of the posterior surface of the heart. In those cases, in which R-T elevation and T-wave inversions appeared in all leads, it was considered that infarction of both surfaces of the heart had occurred.

and considering the mortality of the first attack alone, the rate has actually decreased to less than one-third, i. e., from 36 per cent to 10 per cent. Yet the only change in the method of treatment in this latter period (1934-1936) had been the institution of undernutrition.* Previously cardiac patients were given the ordinary hospital diet; indeed when a "cardiac" diet was specified, it was, as a rule, high carbohydrate, high calorie. It would, therefore, seem logical to conclude that our improved results may be due to undernutrition. It is particularly significant, we think, that the mortality rate of the first attack has been so conspicuously reduced, for it is during the initial attack that treatment would have the greatest effect on the outcome. After all, patients during their second or subsequent attacks are likely to be very ill, possibly beyond all help; and they are also the patients most likely to succumb in the first twenty-four hours before any treatment can be effective. A study of the mortality reports in the literature of the past few years

TABLE III

COMPARISON OF METHODS IN TREATMENT OF CORONARY ARTERY THROMBOSIS

YEAR	ATTACKS	DEATHS	MORTALITY RATE (%)	MORTALITY EXCLUSIVE 1ST 24 HR. (%)	MORTALITY 1ST ATTACK (%)
1930-32*	131	52	39.7	33.6	36
1933-34†	111	45	40.5	33.0	37
1934-36‡	145	30	20.7	16.0	10

*Regular diet. Digitalis and nitroglycerin.
†Regular diet only. (1933 to May, 1934)
‡Undernutrition only. (May, 1934, to 1936)

(Table IV) indicates that these rates are much higher than those in our series treated with low calorie diets. The mortality rate of American and foreign authors for all attacks ranged from 38 to 53 per cent, whereas ours was 16.5 per cent; and for the first attack only, their rates were 24 to 35 per cent as against 8 per cent in our cases. We believe that this difference cannot be explained, except perhaps in very small part, on the basis of recognition of mild cases through better diagnostic acumen. For although we have included such cases, we have also included severely ill patients hitherto classified as suffering from congestive heart failure, auricular fibrillation, and peripheral shock. Furthermore, the statistics quoted for comparison cover the years immediately preceding our test period, and it is probable that in both instances the same criteria were used for the diagnosis of coronary thrombosis.

Clinical observation also has emphasized the value of the low calorie diet. In the great majority of cases pain disappeared after the first two days of this diet. If a regular diet was resumed too soon, pain

*It should be noted that in 1930 and 1931, digitalis and nitroglycerin were used not infrequently, yet the mortality rates in these years were approximately the same as those for 1932 and 1933 when the use of these drugs had been discontinued.

TABLE IV

MORTALITY RATE AND METHOD OF TREATMENT FOR CORONARY ARTERY THROMBOSIS BY DIFFERENT AUTHORS*

	PARKINSON & BEDFORD 1928	LEVINE 1929	CONNER & HOLT 1930	COOMBS 1932	CLARK 1933	PADILLA & COSSIO 1934	HOWARD 1934	COOKSEY 1935	JERVELL 1935	MASTER, JAFFE & DACK 1936
No. cases	100	143	287	144	19	92	165	53	65	267
Mortality 1st attack			24%			27-35%	24.2%			8%
Exclusive sudden death	32%			34%						
All attacks		53%			47.6%	38%		39.6%	47.7%	16.5%
Treatment										
Nitroglycerin	0	0								0
Digitalis	+	+					Fibrillation			0
Adrenalin		Early shock					0			0
Quinidine		Vent. tachycardia								0
Rest	+	+					+	+		+
Morphine	+	+					+			+
Oxygen		+					+			+
Diet		Soft solid					High carbohydrate			800 cal.

*Blank spaces indicate no mention by author; 0 signifies treatment considered contraindicated.

often recurred. Patients learned that small meals were most agreeable and occasionally difficulty was experienced in persuading them to eat more food. Foods like fruit juices and milk and cream, which the patient could not ordinarily tolerate, were easily taken when the low calorie diet was instituted. In the stage of shock it is obvious that forcing food may not only produce symptoms but actually may be dangerous to the patient. It is only logical to give small quantities of food such as 300 to 700 calories a day, as the whole organism requires complete rest.

The close relationship between cardiac function and ingestion of food has been commented upon frequently. Heberden[38] in 1768 noted that his patients developed an anginal syndrome after meals. Karrel[39] reported the value of a low calorie milk diet. Roemheld[40, 41] has written in detail of the gastrocardiac syndrome and believes that distention of the stomach caused by a heavy meal interferes with the action of the heart. He found that distending the stomach produced an anginal syndrome, extrasystoles, tachycardia, faintness, belching, etc. Using the x-ray, Levyn and Rose[42] arrived at similar conclusions. In experiments on animals, extrasystoles, auricular flutter, auricular fibrillation, etc., have been produced by manipulation of the abdominal viscera.[43, 44, 45]

Food and Cardiac Output.—Another explanation of the beneficial influence of diminished food ingestion on the heart lies in the resulting decrease in metabolism with its accompanying decrease in cardiac output. Grollman[22] and Kisch and Schwarz[46] and Jarisch and Liljestrand[47] and, more recently, Gladstone[48] have demonstrated a rise in cardiac output following a meal. Wayne and Graybiel[49] in their clinical study of angina pectoris reasoned that the pain brought on by a meal was due to the added strain on the heart. These authors and also Master[50] found that exercise tolerance was reduced after a meal.

Additional evidence of the effect of food restriction on the body metabolism is provided by the work of Soderstrom, Barr and DuBois,[51] who showed that small meals when frequently taken produce less specific dynamic action than the same food divided into three meals. McCann[52] and Richardson and Mason[53] showed that following starvation the specific dynamic action of food is less than when following a regular diet. In a diet of 800 calories both these factors are in play.

The value of low calorie diets in patients with coronary thrombosis is thus confirmed by experimental and clinical observations. A patient at complete rest requires less food and less food intake makes correspondingly smaller demands on the heart muscle.

Effect of Undernutrition on the Circulation.—In previous articles[34-37] we have reported the effect of undernutrition on the basal metabolism and the circulation of patients suffering from coronary artery disease. In forty-two patients it was shown that the basal metabolic rate could be

lowered to –20 to –35 per cent and that, by varying the amount of food, the patient could be maintained at definite levels of basal metabolism. To attain the drop in basal metabolic rate to –20 to –30, a loss of at least 6 per cent of the initial body weight was necessary. This loss of weight appeared harmless. Indeed, to a patient who is overweight, it is valuable, for in the overweight the domes of the diaphragm are elevated and the vital capacity is diminished. Exercise tolerance is definitely reduced and studies in circulatory dynamics show that the obese patient is handicapped.[54]

Low Calorie Diet and Work of Heart.—The postulate that a lowered basal metabolic rate has a favorable effect on the heart is not novel. In 1900 Hirschfeld[55] concluded that undernutrition lightened the work of the heart. Lusk[56, 57] was aware of the beneficial influence of a low basal metabolic rate upon the cardiovascular system. DuBois[58] very recently expressed the hope that a drug capable of depressing metabolism would be introduced in the treatment of heart disease. A low calorie diet may satisfy this need.

The effect of the low calorie diet on the heart and circulation has been specifically investigated in our previous studies[34-37] (Table V). It was shown that the pulse rate in our patients fell to 50-60 beats per minute and occasionally below 45. After the pulse and blood pressure readings had remained constant for several weeks, an increase in the diet produced a definite rise in pulse rate. The systolic, diastolic, and pulse pressures were also raised. Benedict and his coworkers[59] and also Rubner[60] reported similar effects on blood pressure and pulse in normal subjects. Since the work of the heart is dependent upon the blood pressure and pulse rate,[61, 62] it is evident that undernutrition by lowering basal metabolism decreases the work of the heart.

Slowing of the pulse rate not only lessens the work of the heart but has been shown experimentally to be most efficient for the heart since less oxygen per unit of time is required for a given amount of work.[63-65]

That a reduction in basal metabolism diminishes the work of the heart was shown directly by Altschule,[66] who measured the cardiac output following total thyroidectomy. He found that a drop in basal metabolic rate of 30 per cent effected a reduction of 40 per cent in the work of the heart. A similar study[67] was made by Dack in one of our patients in whom the cardiac output measured 2.76 liters per minute (Table V) after the basal metabolic rate had dropped to –30 per cent. On an increased diet, the basal metabolic rate rose to –5 per cent and the cardiac output to 4.15 liters. The pulse rate which had averaged 58 on the low diet rose to 71; the systolic blood pressure rose from 96 to 128 mm.; and the diastolic from 65 to 86 mm. Hg. From these observations it was calculated that there was a reduction of 49 per cent in the work of the heart during the low calorie intake.

TABLE V

INFLUENCE OF UNDERNUTRITION ON CARDIAC OUTPUT AND WORK OF HEART
(H. F., MALE, AGED 40)

DIET CALORIES	B. M. R. PER CENT	PULSE RATE	BLOOD PRESSURE		CARDIAC OUTPUT LITERS/MIN.	CARDIAC WORK KG. M./MIN.
			SYSTOLIC	DIASTOLIC		
800	-30	58	96	65	2.76	3.0
2,000	-5	71	128	86	4.15	5.9
Change	-25%	-18%	-25%	-24%	-32%	-49%

No Loss of Cardiac Efficiency in Undernutrition.—The reduction in cardiac output during undernutrition is not associated with diminished cardiac efficiency. This was shown by Benedict and his associates[59] and by Chittenden[68] and Jaffe, Poulton and Ryffel,[69] who studied the response of their patients to exercise. Despite a continued low basal metabolic rate, our patients, too, showed no diminution in vital capacity, exercise tolerance, or blood velocity and were able to return to moderate activity while still undernourished. Pain was minimal. These observations on metabolism and circulatory dynamics in our patients indicate that the low calorie diet is beneficial to the heart.

Possible Ill-Effects of Diet.—No ill-effects were noted during prolonged underfeeding. The blood sugar, blood protein, and blood cholesterol remained normal. Lusk[56, 57] and Rubner[60] have shown that loss of body protein is very slight on a diet similar to ours. Acetone was never found in the urine, and no evidence of dehydration or myxedema was observed. The general good health of the patient was maintained even after months on the 800 calorie diet; indeed, the patients felt so well that it was often difficult to persuade them to increase their food intake.

SUMMARY

1. Two hundred and forty-three patients suffering from coronary artery thrombosis were treated by a low calorie diet and prolonged rest in bed. Digitalis, adrenalin, or nitrites were not used.

2. The mortality rate in 267 attacks was 16.5 per cent; in first attacks only 8 per cent. Most patients survive an initial attack of coronary thrombosis. Almost one-half of our patients had suffered one or more previous attacks.

3. Coronary thrombosis is not uncommon in women. The ratio of men to women was 3 to 1. It occurs not infrequently in the fourth and fifth decades and the prognosis in these is better than in the older age groups. The average age in our series was fifty-four years.

4. Hypertension, which preceded the attack in 66 per cent of cases, did not directly influence the prognosis. When coronary thrombosis occurs in women, hypertension or diabetes is usually present.

5. Infarction of the anterior and posterior surface of the left ventricle occurs with equal frequency; there is no difference in prognosis.

6. Irregularities of the heart developing during an attack were transitory in most cases and required no specific treatment.

7. Evidence is given that the good results reported in this series may be attributed in part to the undernutrition therapy which eliminates gastrocardiac reflexes, minimizes the rise in metabolism and cardiac output which usually follows a meal, and gradually lowers the basal metabolic rate. This effects a decrease in pulse rate and blood pressure, and so a diminution in the work of the heart.

8. No ill effects were observed following the use of the low calorie diet.

9. Instances of coronary artery thrombosis occur which are inevitably fatal because of the size of one or several simultaneous infarctions or because of the severe degree of involvement of all the coronary vessels. From this series of cases, however, it appears that in the main the prognosis of an attack is hopeful and, indeed, death in the first attack is infrequent.

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A STUDY OF THE CARDIAC OUTLINE*

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THE practice of cardiac radioscopy is based on our knowledge of the relative positions of the chambers of the heart and the conception that each chamber may be rendered border-forming by rotating the patient into suitable positions. The relative length of each segment of the cardiac silhouette and its degree of curvature offer valuable information concerning the size and depth of the outlined chamber.

Emphasis has been placed recently on cardiac enlargement as a prognostic sign in heart disease.[1] Increase in the size of a single chamber

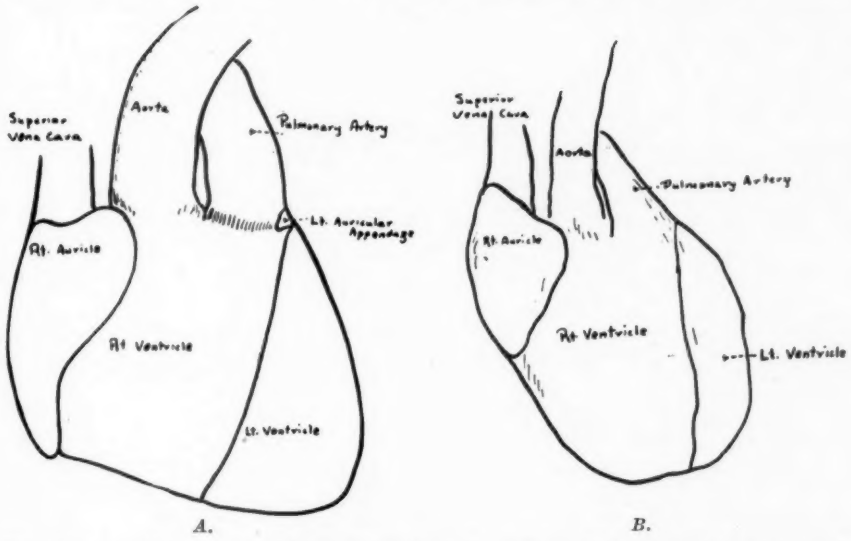

Fig. 1.—*A*, outline of normal heart in situ. *B*, outline of the same heart removal from the thorax.

is of the greatest importance. Recent interest in the radiological appearance of individual chamber enlargement and the position and configuration of the great vessels has prompted this study.[2]

Post-mortem examinations of the heart in situ were made in twenty-eight cases. The trachea was clamped before the sternum was removed in the first six cases in an effort to keep the lungs relatively inflated. Subsequent observations showed that this precaution was unnecessary since minor displacements of the lungs did not affect the position of the heart appreciably. Manipulation of the diaphragm, preexisting

*From the Radiologic Service of Dr. A. J. Bendick and the Medical Service of Dr. L. Lichtwitz, Montefiore Hospital, New York City.

hydrothorax, or pleural adhesions of minor degree did not alter the cardiac configuration or position. Pleuropericardial adhesions likewise did not influence the situation of the cardiac borders, in the absence of intrapericardial adhesions, unless they were extensive.

After the sternum was removed, the pericardium was opened widely. An accurate sketch of the heart in situ was made. The size and exact positions of the various cardiac segments and great vessels were noted. Despite the facts that films taken during life were taken in the erect position at a 2-meter distance and the post-mortem measurements were made with the body in the supine position, the measurements were in fair agreement. But the difference in the configuration of the heart

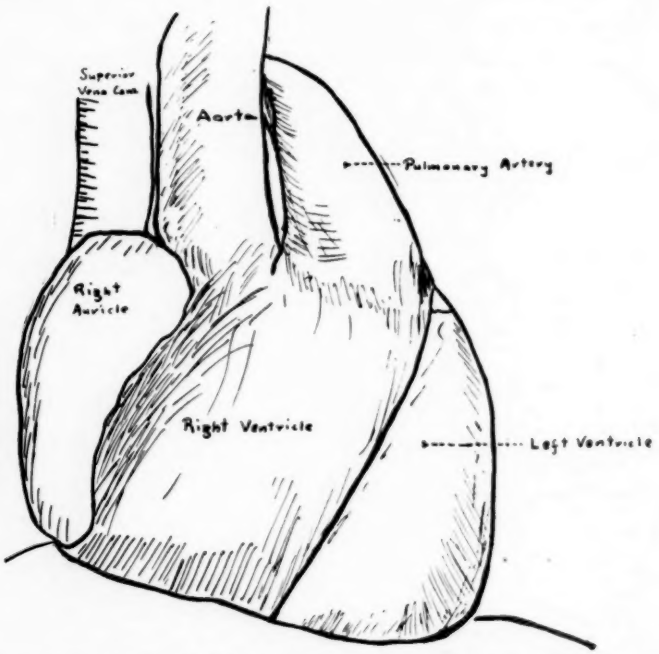

Fig. 2.—I. E., male, aged thirty-seven years. Bilateral tuberculosis. The left auricular appendage appears as a small triangular area at the junction of the pulmonary artery and left ventricle.

borders and their relative positions before and after removal of the organ from the body were particularly striking (Fig. 1).

It is understood that the correlation offered by this study is approximate at best. We cannot take into account the effect of the rotation of the heart during systole or the results of the relaxation of the cardiac musculature during diastole. It is doubtful, however, whether these factors are of clinical significance.

The left border of the normal heart is formed by three main arcs. These consist of the arch and upper thoracic portion of the aorta, the pulmonary artery, and the left ventricle. An elongated left auricular

appendage is sometimes seen extending from between the two left pulmonary veins to a position near the junction of the pulmonary artery and the left ventricle. This may form a small portion of the border, but is insignificant for all practical purposes (Fig. 2).

A small portion of the pulmonary conus is sometimes seen on the left cardiac border in the more hypoplastic type of heart (Fig. 3). The second left arc in these individuals consists of two portions, the pulmonary artery lying above the conus. The pulmonary artery is always the longer of the two segments. The left auricular appendage may extend from behind to overlap partially the conus, thereby increasing the apparent convexity of the arc.

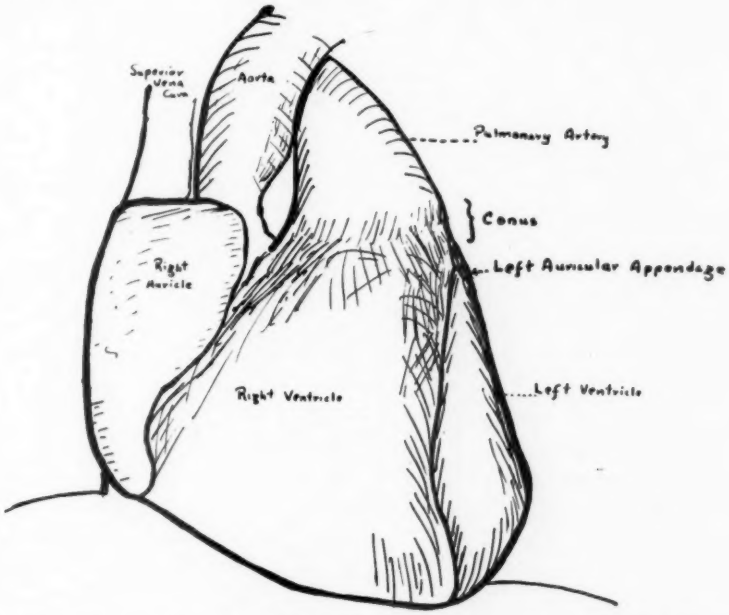

Fig. 3.—E. G., female, aged thirty-five years. Brain tumor. The pulmonary conus is border-forming on the lowermost part of the second left arc, immediately above the left auricular appendage.

The right border of the normal heart is formed entirely by the lateral border of the right auricle (Figs. 2 and 3). The right auricular appendage is situated anterolaterally and occupies the upper two-thirds of the right border. It is a wide chamber in free communication with the body of the auricle, and may extend as far anteriorly as the midline of the heart. The lower one-third of the right auricle lies more posterolaterally and varies considerably in its transverse diameter. At times it measures but 1 cm. across. One cannot estimate the transverse extension of this chamber in the postero-anterior projection because its mesial border is lost against the dense shadow of the remainder of the heart.

The superior vena cava is frequently visualized arising from the upper part of the right border. Infrequently one may demonstrate the supradiaphragmatic portion of the inferior vena cava.

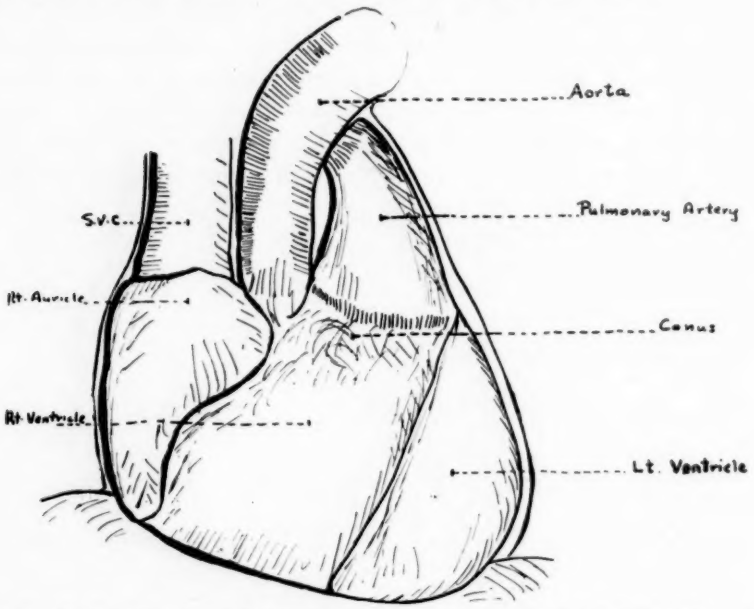

Fig. 4.—C. B., female, aged twenty-seven years. Advanced bilateral tuberculosis. The pulmonary artery of the drop type of heart courses parallel to the aorta for an appreciable distance.

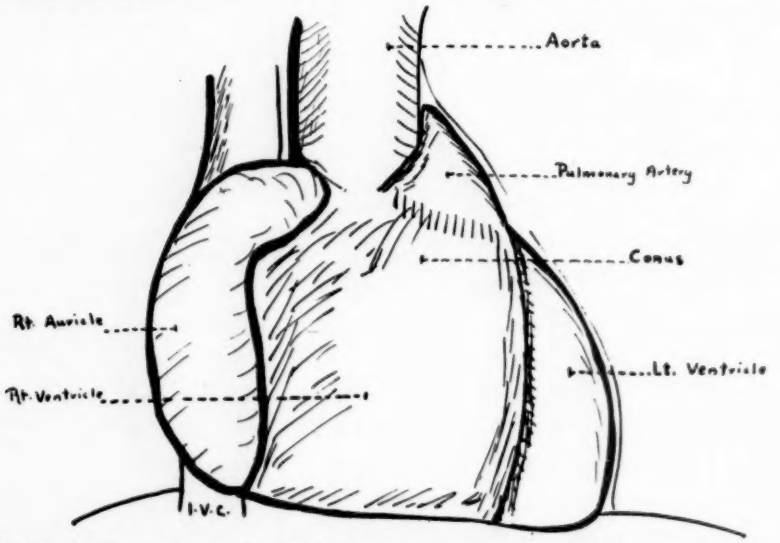

Fig. 5.—C. R., male, aged sixty-five years. Carcinoma of the larynx. The pulmonary artery of the transverse type of heart approximates the aorta for only a short distance.

The diaphragmatic surface of the heart is formed in most part by the right ventricle. The inferior vena cava and, to a more appreciable

extent, the apex of the left ventricle form the outermost portions of the diaphragmatic area.

The body of the left auricle is never border-forming in the frontal projection of normal hearts. It may be seen occasionally as a circular or oval shadow of slightly increased density in the center of the cardiac silhouette. Dilatation of the left auricle may cause its right border to project beyond the shadow of the right auricle. Displacement of its left lateral border beyond the shadow of the second and third left cardiac segments is very unusual, even in the presence of excessive

Fig. 6.—The pulmonary artery is well outlined in the left oblique position. The aortic impression against the barium filled esophagus is seen just above the pulmonary artery.

auricular dilatation. I have been able to find but one such case in the literature.[3] Another is reported at the end of this paper.

The left auricular appendage is rarely dilated appreciably. This may be ascribed to its dense structure and its comparative isolation from the body of the auricle.

The angle of origin of the main stem of the pulmonary artery from the conus or outflow portion of the right ventricle is of interest. The artery arises almost perpendicularly from the conus in the normal "drop" type of heart, courses parallel to the aorta for as much as

from 5 to 7 cm. before it spirals around the aorta and divides into the right and left pulmonary arteries. Its origin in the more transverse type of heart is more oblique and, as a rule, the main stem is shorter (Figs. 4 and 5). Frequently a part of the left main branch can be seen in the frontal view springing from the upper portion of the second left segment. One is able in some cases to trace almost the entire length of the left pulmonary artery by rotating the patient slowly into the left oblique position while observing the left pulmonary artery (Fig. 6).

The superior interventricular indentation is usually located at the point where the pulmonary artery swings vertically away from the

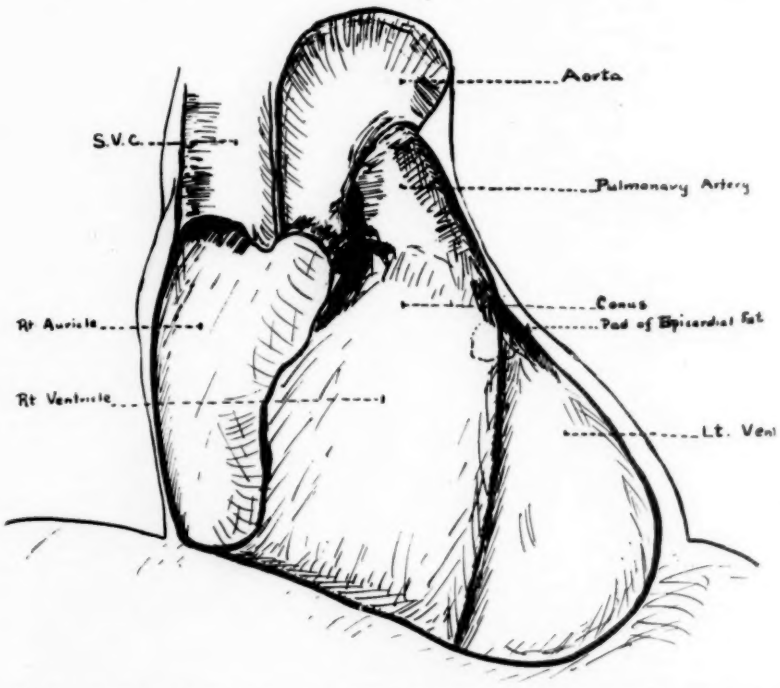

Fig. 7.—S., male, aged forty-seven years. Polycythemia vera. Heavy deposits of subepicardial fat obscures the superior interventricular indentation.

left ventricle. Its level can be approximated fluoroscopically by noting the point on the left cardiac border where the lower and middle segments pulsate forcibly in opposite directions—the so-called "oscillating point." This can be differentiated from the twitching pulsation of the left auricular appendage when it is border-forming. A gas-filled stomach bubble often enables one to visualize the apex, and is of considerable aid in determining the true extent of the left ventricular segment. The inferior interventricular indentation can be identified in the right oblique position, and occasionally is demonstrable in the postero-anterior position through the stomach bubble.

The position of the anterior interventricular sulcus may be estimated by drawing a line between the inferior interventricular indentation to the oscillating point between the second and third left cardiac segments. In order to localize the septum, it would be necessary to localize the posterior interventricular sulcus. I know of no method for doing this, since any rotation of the heart changes the posterior sulcus' position. Even if one could accurately localize both sulci, it would be extremely difficult to determine whether and how far the interventricular septum bulges into the right ventricle.

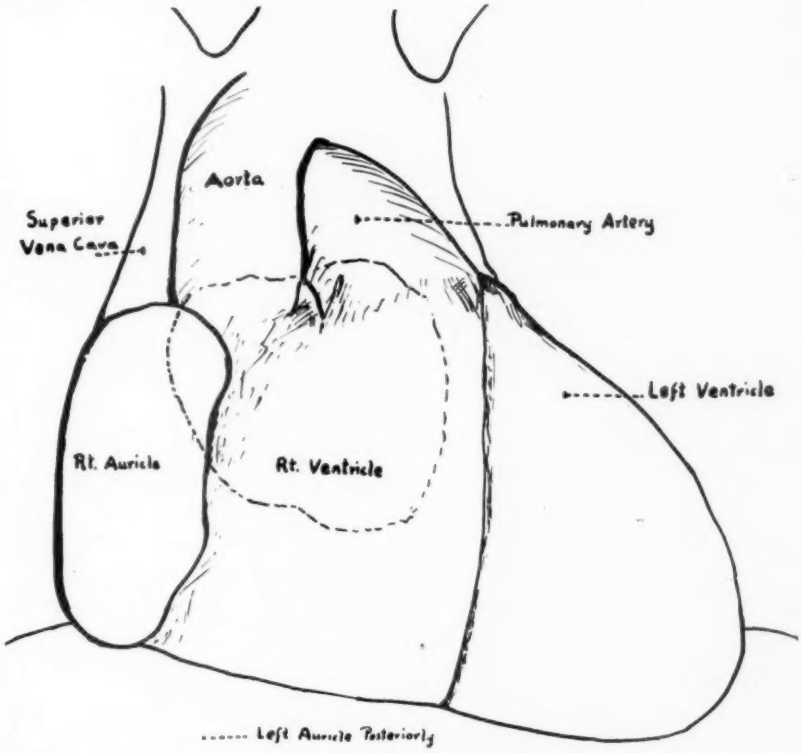

Fig. 8.—L. N., male, aged forty-one years. Uremia. The left auricle is deviated to the right because of the clockwise rotation of the heart produced by the enlarged left ventricle.

When the heart is seen in situ with the pericardium open, each segment is clearly outlined. As seen on the radiogram, the borders are usually smooth. It has been suggested that this may be due to the shadow cast by the pericardial sac. Heavy deposits of subepicardial fat (Fig. 6*), or thick pericardial adhesions may also obscure normal separating points. Pericardial effusions of appreciable degree completely obliterate all landmarks.

*The film for Fig. 6 is reproduced through the courtesy of Dr. M. G. Wasch of the Jewish Hospital of Brooklyn.

The characteristic findings of chamber enlargement have been adequately described in the literature.[4] Each chamber except the right auricle enlarges in a characteristic fashion.

During the course of this study several instances were noted in which massive enlargement of the left ventricle rotated the heart clockwise, thereby displacing the left auricle toward the right. In these instances the esophagus was deviated slightly to the right (Fig. 8), but there was no elevation of the left main bronchus.

CASE REPORT (FIG. 9)

R. O., a twenty-two-year-old girl was admitted with complaints of shortness of breath and palpitation. She had had rheumatic polyarthritis with cardiac in-

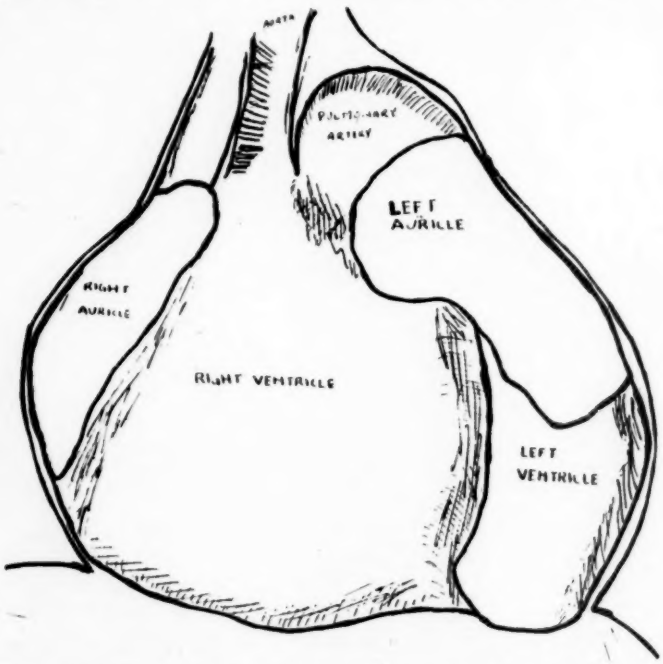

Fig. 9.—R. O'N., female, aged twenty-two years. Chronic rheumatic cardiovalvular disease with mitral stenosis. The left auricle forms approximately half of the left border. Note that the enlarged right ventricle has rotated and elevated the right auricle.

volvement at the age of five years, followed by an episode of chorea lasting several weeks at the age of eight years. Patient first noted dyspnea, palpitation and pretibial edema at the age of twenty years.

Physical examination revealed a slim, poorly nourished girl. No cyanosis. Lungs clear. Apical impulse in the fifth interspace beyond the midclavicular line. Forceful apex beat with diastolic thrill at the apex. Presystolic and systolic apical murmurs, transmitted upward. Heart action totally irregular. Liver enlarged and tender.

Laboratory Findings.—Hemoglobin, 70 per cent. Saccharine circulation time, 45 seconds; ether circulation time, 9.6 seconds. Sedimentation rate, 12 mm. in the first hour.

Course.—Liver remained enlarged despite mercurial diuretics. Patient died two months after admission.

Report of X-ray of Chest.—"The heart is globular in shape and shows marked enlargement of the left ventricle with a marked posterior bulge. There is marked enlargement of the outflow tract and inflow tract of the right ventricle. The left auricle is seen as a central shadow of increased density in the postero-anterior view. It is enlarged horizontally and elevates and compresses the left bronchus in the vertical position. The aorta is hypoplastic, and the heart is rotated."

Clinical Diagnosis.—Chronic rheumatic cardiovalvular disease, with mitral stenosis and insufficiency, auricular fibrillation, congestive heart failure.

Post-Mortem Findings.—Heart weighed 425 gm. Right auricle was dilated. The right ventricle was markedly dilated and hypertrophied, the dilatation involving both the inflow and outflow tracts. The left auricle was tremendously dilated. The auricular appendages were free. The left ventricle was slightly dilated. The mitral valve was stenosed, showing a calcified "fish-mouth" opening. The pulmonary artery and left main bronchus were elevated. The aort was hypoplastic.

SUMMARY

The cardiac borders were studied in situ in twenty-eight cases. The following points are emphasized.

1. The left auricle rarely appears on the left border. The left auricular appendage may be border-forming, but it is rarely of any significance.

2. The pulmonary artery forms the major portion of the second left cardiac arc.

3. The angle of origin of the pulmonary artery with the conus may vary considerably. The length of the second left arc varies directly with the length of the pulmonary artery. The more perpendicular variety is usually the longer.

4. Enlargement of the left ventricle may rotate the heart clockwise, thereby displacing the left auricle toward the right without dilatation of the latter chamber. In these instances deviation of the barium-filled esophagus to the right does not necessarily indicate an enlargement of the left auricle.

5. An unusual case of left auricular dilatation is presented.

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A STUDY OF THE QRS COMPLEX OF LEAD III IN LEFT AXIS DEVIATION*

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IN THE routine analysis of the electrocardiogram, one is impressed with great variations in the configuration of the conventional third lead. These variations are conspicuous in that class of tracings which show left axis deviation. This analysis has been undertaken to attempt to group those records showing left axis deviation into a number of subdivisions, chosen upon the general pattern of the QRS complex as displayed on inspection and not upon degree of axis deviation, in order to demonstrate any varying significance of these patterns in disease, and, if possible, to attach diagnostic significance to changes in the much neglected Lead III.

Four hundred thirty-one records were analyzed, representing all the tracings showing left axis deviation in 1,781 consecutive electrocardiograms of subjects on whom adequate clinical data were available. Left axis deviation occurred in 24.2 per cent of the 1,781 electrocardiograms reviewed and was considered present in those tracings which displayed the major deflection upward in Lead I and downward in Lead III. Usually R_2 was smaller than R_1 but in twenty-two cases R_2 was greater than R_1. The inclusion of this group will be discussed later. In no case was a record with a QRS width greater than 0.10 sec. included. Bundle-branch block and defective intraventricular conduction were thus eliminated. All cases were classified clinically, upon the criteria of the American Heart Association,[1] into "definite," "possible," "potential" and "no heart disease" groups in a rigid and critical clinical survey. For analysis in this paper, however, the cases were divided into "definitely" and "not definitely" diseased groups, the latter including those patients in the "normal," "possible" and "potential" divisions, so as to influence favorably any conclusions which may be drawn from the analysis.

A review of the 431 records disclosed seven general patterns, as shown in Fig. 1. The frequency of their occurrence, together with the number and percentages of patients showing the presence or absence of definite clinical heart disease, is summarized in Table I.

Definite heart disease often occurs in individuals with normal electrocardiograms. In 100 consecutively studied patients with heart disease, Proger and Minnich[2] found 38 per cent with normal electrocardiograms.

*From the Department of Medicine and the Hutchinson Memorial Clinic, School of Medicine, Tulane University of Louisiana.

Only 65.4 per cent of the present series of patients with left axis deviation were proved to have definite heart disease clinically. This estimate may, however, be too low because of the conservative method of classifying patients. On the other hand, one cannot safely ascribe 65.4 per cent of the instances of left axis deviation to heart disease, for a portion of this group, as in the 34.6 per cent not diseased, would undoubtedly show left axis deviation in the absence of disease. And so it is with other electrocardiographic changes. It is not only the frequency of the occurrence of a change in diseased hearts but the infrequency of its occurrence in the normal heart that establishes its value. Since most patients on whom electrocardiograms are taken are suspected of heart abnormalities, one must use care in evaluating unusual changes in these patients.

The curve pattern shown in Fig. 1, *A*, represents the most frequent Lead III type seen in this series. It occurred slightly more often in those without demonstrable disease (51.6 per cent) than in those with definitely diseased hearts (48.4 per cent). Almost invariably in the ab-

TABLE I

GROUP	NUMBER OF DISEASED PATIENTS	NUMBER OF PATIENTS NOT DISEASED	TOTAL
A	77 (48.4%)	82 (51.6%)	159 (36.8%)
B	29 (72.5%)	11 (27.5%)	40 (9.2%)
C	25 (75.7%)	8 (24.3%)	33 (7.9%)
Significant Q_3	22 (85.0%)	7 (15.0%)	29 (6.7%)
D	108 (71.1%)	44 (28.9%)	152 (35.2%)
Curves of Proger and Minnich	30 (93.7%)	2 (6.3%)	32 (7.4%)
E	21 (91.3%)	2 (8.7%)	23 (5.3%)
F	2 (66.7%)	1 (33.3%)	3 (0.7%)
G	8 (88.9%)	1 (11.1%)	9 (2.1%)
H	8 (66.7%)	4 (33.3%)	12 (2.8%)
Total	282 (65.4%)	149 (34.6%)	431 (100.0%)

sence of disease, and often in the presence of disease, this curve type occurred in patients of the hypersthenic habitus, usually with obesity. Inversion of P_3 and T_3 was often associated, concerning which, at present, I am reporting no analysis. Proger,[3] in a study of 100 obese individuals with and without heart disease of the hypertensive type, found left axis deviation as frequently, and almost to the same degree, in simple obesity as in patients with obesity, hypertension, and cardiac hypertrophy. He concluded that axis deviation in the electrocardiagram of the obese patient is of no value as an aid in the diagnosis of relative ventricular hypertrophy. My experience in this group confirms his statement. The predominance of the nondiseased group in this series is due to a great extent to the fact that hypersthenic and obese individuals were often referred for electrocardiograms because the body type with "transverse heart" leads frequently to suspected enlargement clinically.

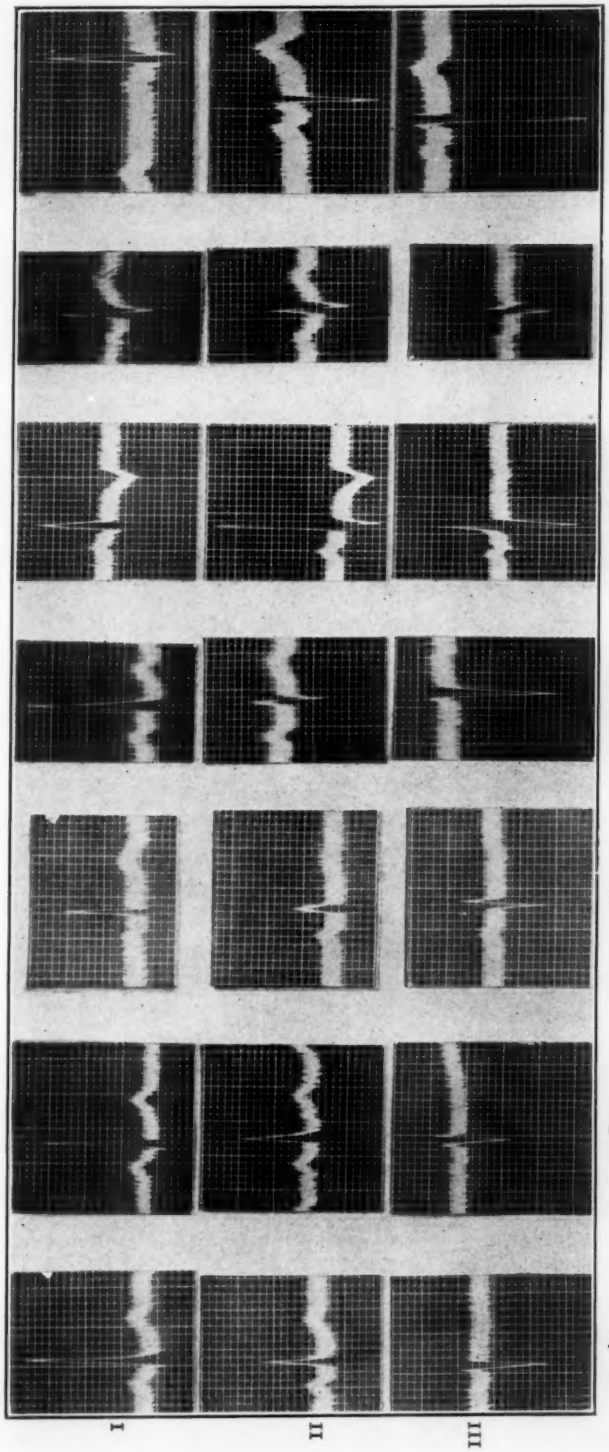

Fig. 1.—Curves illustrating Groups A to G tabulated in Table I.

Group B, as shown in Fig. 1, *B*, appears to be a variation of Group A. It represents a type of curve which may be included in a group previously described by Katz and Slater.[4] Although they state that this curve has not been mentioned before, it is similar to Pardee's M-shaped QRS_3. They have analyzed those cases showing left axis deviation in which there is a distinctly positive R_3 followed by an S_3, the upward stroke of which rises above the isoelectric level. All of the present group fit the criteria of Katz and Slater. Cases without the second positive deflection or, unlike those cases of Katz and Slater, those with a second positive deflection of 1 mm. or less were placed in Group A, as were those with a suggestive but not distinct initial upward deflection. Furthermore, I have included no cases with QRS complexes lasting more than 0.10 sec.

This Group B type of curve appeared in 320 (4 per cent) of 8,000 records analyzed by Katz and Slater. In the present series, 40 cases (2.3 per cent) were found in 1,781 records. This lower incidence may be ascribed to many factors. Variations in type of patients (for example, negroes) may play a part. Katz and Slater's patients appear to have been in part bed patients. The present series is composed entirely of ambulatory patients. Furthermore, there were certain differences in the criteria used. Their cases include in part, as evidenced by their *Fig. 11*, certain examples of definite right bundle-branch block.

Eighty-six per cent of their 50 analyzed cases showed clinical evidence of heart disease. Of the remaining 7 patients, 5 were in the arteriosclerotic age group (40 to 54 years). In the present group of 40 cases, 29 (72.5 per cent) were definitely diseased, while the remaining 11 (27.5 per cent) were not. Again this discrepancy in figures may be ascribed to the factors causing variations in incidence. For example, the removal of those patients with right bundle-branch block would certainly change the ratio of diseased to nondiseased patients.

In three instances the second positive deflection in Lead III was of great amplitude (5 mm. or more). These patients were definitely diseased. The effect of the second positive deflection in these three patients upon Lead II (Fig. 2, *D*), together with its interpretation, will be more clearly understood in the discussion under the heading "General Discussion." The T-wave changes in relationship to the second positive deflection are now under investigation in this laboratory.

The third group, as shown in Fig. 1, *C*, is the so-called Q_3 type of curve in accompaniment with left axis deviation, comprising 33 cases (8 per cent). This figure represents 1.8 per cent of all records reviewed. In appearance the curves differ essentially from those of Group A, and especially Group B, in the absence of an initial upward deflection. Twenty-nine, or 88 per cent, of these records met the criteria for significant Q_3 as laid down by Pardee,[5] that is, normal or left axis deviation of the QRS combined with a large Q_3 which is 25 per cent or more of the largest deflection of the QRS complex in any lead. Twenty-two of the

25 in the diseased group fell into this category. Of the 8 nondiseased patients, 7 fell into this group (88 per cent). Although the present series includes only left axis deviation, omitting 3 pregnant women, 85 per cent of the patients with Pardee's criteria were definitely diseased. Among the 7 nondiseased patients, 3 were pregnant; one was fifty-six years old and showed peripheral vessel sclerosis but no evidence of cardiac abnormalities; and 3 were apparently normal. These 3 were of the hypersthenic habitus.

Pardee[5] suggests that a large Q_3 indicates disease of the left ventricle, while others ascribe it to septal disease. Its occasional occurrence in normal hearts, he states, may be due to unusual distribution of the His bundle and/or to a high position of the diaphragm, as a contributory factor. He found a significant Q_3 in only 2 of 277 records taken from normal hearts. Edeiken and Wolferth[6] found no significant Q_3 in 709 apparently normal college students, but in 1,900 unselected electrocardiograms he found a significant Q_3 in 78 (4.1 per cent) of whom 63 (84 per cent) had definite heart disease, 7 were doubtful, 5 had no heart disease, and 3 were unclassified. Although the present series contains only left axis deviation, the percentage of diseased patients (85) corresponds closely with Edeiken and Wolferth's comparable series. Borg[7] found a deep Q_3 in 78 records taken from 1,819 electrocardiograms, but only one such Q_3 in a normal individual. Willius[8] found this peculiarity in only 3 normal individuals among 300 cases. One of his published records (*Fig. 1,* middle record) and one of Pardee's (*Fig. 1, D*) appear to have an initial upward deflection in Lead III. If this were so, these records do not meet the criteria. However, the several complexes shown in the illustrations are not sufficient for judgment of these records, which must rest upon views of longer strips, to rule out the possibility of muscle tremors and artefacts as a cause of small initial upward deflections. This problem may be a real one, as pointed out by Fenichel and Kugell.[9]

The tracings of Cohn and Raisbeck,[10] taken by rotating the leads upon the normal subject to produce the effect of counterclockwise motion of the heart (left axis deviation), show the occurrence of a large Q_3 (Cohn's *Figs. 4 and 5*). In Edeiken and Wolferth's group of pregnant women, two typical Q_3 curves in late pregnancy disappeared following delivery. Pardee had shown the same change. Feldman and Hill[11] found 5 Q-waves of significance in 36 normal pregnancies. Carr, Hamilton and Palmer[12] in an electrocardiographic study of 342 pregnant women found 17 (4.9 per cent) in whom a significant Q_3 was continuously present. Thirteen of these women showed no definite or suggestive cardiac changes. In 3 (4.2 per cent) of 71 pregnancy records reviewed in the present series, a significant Q_3 was seen. I ascribe the changes, as do others, to changed position of the heart, a "transverse heart," or possibly a rotation of the heart upon its axis or the vertical axis of the body.

Such an explanation would also satisfy the findings in the 3 normal hypersthenic individuals in the present series and agrees with the findings of Cohn and Raisbeck. These curves are no doubt variants of the changes described in Groups A, B, and D, due to changes in cardiac position. Such findings cast no doubt upon the genuineness of the meaning of the Q_3 in coronary disease but emphasize the importance of the evaluation of the electrocardiogram not by itself but in terms of the individual patient.

I shall again consider the Q_3 curve under general discussion.

The second most frequent type of curve encountered was that of the pattern shown in Fig. 1, *D*. This type of curve combines the presence of left axis deviation with a definite S_2 of varying amplitude, with S_1 absent or smaller than S_2. There were 152 such patients, representing 35.2 per cent of the entire group. Of these, 71.1 per cent were definitely diseased, 28.9 per cent were not. In comparison with Group A, it will be seen that 71.1 per cent of the patients were definitely diseased, as opposed to 48.4 per cent in absence of the S_2 (Fig. 1, *A*). The presence of S_2 then distinctly increased the possibility of the presence of heart disease from 48.4 per cent to 71.1 per cent in this series.

An attempt has been made recently to analyze certain of the members of this broad group in association with the presence of other defects.[2] The criteria used in that study were: (1) an inverted or low erect T_1, less than one-seventh of the R-wave; (2) an S_2 of at least one-half the amplitude of R_2; and (3) an erect T_3 greater than T_1. Proger and Minnich[2] found 40 such records in 136 cases of left axis deviation. Thirty-eight (95 per cent) of their patients had obvious heart disease, an incidence of disease "sufficiently striking to warrant considering such electrocardiograms regularly as distinctly abnormal." In the present series the incidence of such a combination of findings is much smaller, 32 (7.4 per cent) in 431 cases. In 30 (93.7 per cent) of the 32 patients definite heart disease was demonstrable clinically. One patient was, to all methods of examination, entirely normal and another, without demonstrable heart disease, has definite carcinoma of the bronchus with cardiac displacement, which may account for the findings. This analysis in general supports and confirms the findings of Proger and Minnich. In their discussion of the significance of the prominent S-wave in Lead II, they offer no acceptable explanation but consider the possibility of its association with cardiac abnormalities in the manner of T-wave disturbances. An attack upon the explanation of this problem will be outlined later under "General Discussion." I have included in this group two curves classed in Fig. 1, *E*, both falling in the diseased group and both meeting Proger's criteria.

The group taking the configuration seen in Fig. 1, *E*, occurring with R_2 greater than R_1, violates a usual principle of left axis deviation. Of

course, the major deflection is definitely down in Lead III and up in Lead I. In this group, S_2 was always present, and I believe that the downward deflection in Lead III is distinctly different from that in the previous groups. Of 23 patients (5.3 per cent of all curves analyzed), 2 (8.7 per cent) were not diseased, and 21 (91.3 per cent) were.

Three tracings (0.7 per cent) showed the form portrayed in Fig. 1, *F*. Two of the patients were diseased, one was not.

The final typical picture seen was that shown in Fig. 1, *G*. This group showed left axis deviation with the upward deflection in Lead II conforming closely in height and outline to that of Lead III and, conversely, the major deflection downward in Lead II but always smaller than that

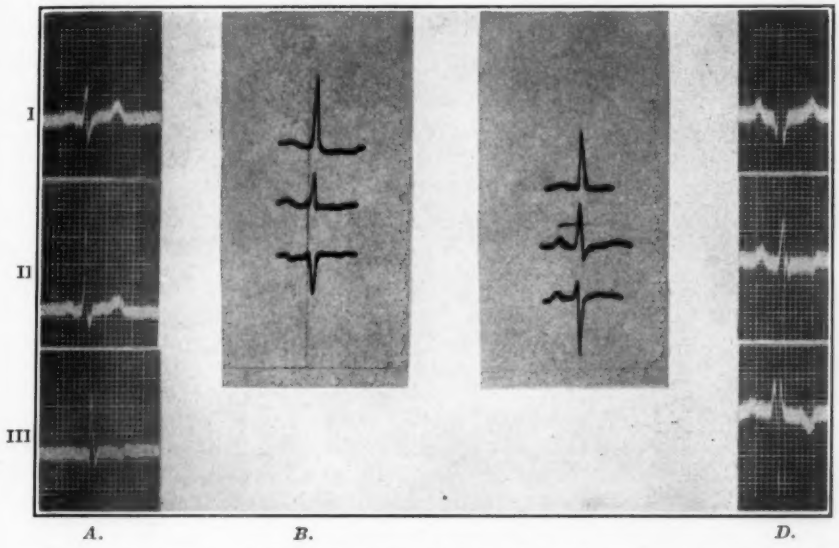

Fig. 2.—*A*, normal electrocardiogram; *B*, *C*, tracings of simultaneous curves taken from Groedel (Das Elektrokardiogramm, Vol. II, Plates 166, 83); *D*, curve illustrating extreme case falling into Group B.

in Lead III. The positive deflections in Leads II and III were usually of low amplitude with rounded peaks and considerable thickening. Eight such curves (88.9 per cent) were recorded from patients with hypertension and definitely enlarged hearts. One (11.1 per cent) was found in a normal individual, as studied clinically and roentgenologically.

Twelve records (2.8 per cent) (Table I, H) showed bizarre tracings which do not fit any of the classes described and had no constant characteristics. Although the group is a miscellaneous one, including notching and splintering of QRS_3, into which, as far as analysis is concerned, one may place Group F, a larger series may disclose members with constant characteristics which will demand establishment of categories of their own.

GENERAL DISCUSSION

A glance at Fig. 1 will disclose a resemblance between some of these curves and those with normal axis deviation. Lead III of Fig. 1, *A*, for example, might well be a complete inversion of the ventricular complex as compared with Fig. 2, *A*. If one assumes that R_3 may become inverted, the possibility exists of the main downward deflection being a Q-wave, an inverted R, an S, or a combination of these three. Einthoven[13] called the chief downward deflection in left axis deviation an inverted R, and today on the Continent this nomenclature is found. Lewis preferred to call this wave an S, and the English-speaking peoples have adhered to his nomenclature. Herrmann and Wilson[14] state that it is unquestionably true that this deflection is produced by the same muscle activity that gives rise in the same cases to the exaggerated R_1, and that we have no more right to call it "S" than we have to call the inverted R_1 of dextrocardia "S" but that it is convenient to avoid speaking of inverted deflections. It appears more confusing to the author, however, to call a wave "Q" at one time and "S" at another, when it is really chiefly R-wave in both cases, and to designate a wave Q or S in different curves when it signifies the same physiological or pathological processes. If one is to discuss the significance of a Q-, R- or S-wave in diagnosis, he must, for intelligent results, refer to the same process each time. Since this appears to be impossible according to Lewis' nomenclature, the author prefers the nomenclature of Einthoven, which has been advocated recently in this country by Hurxthal.[15]

I have chosen to designate Lead III in relationship to the nomenclature of Lead I, which is almost without exception uniformly consistent. This plan involves the designation of time intervals in Leads II and III rather than upward or downward deflections with the letters Q, R, and S. It is best carried out with simultaneous registration of the three leads, or, at least, of Leads I and II, and I and III. However, it may be carried out in routine curves, as usually taken, by the application of Einthoven's principle: Lead II = Lead I + Lead III. Since allowance must be made for changes due to respiration and the resultant shift in cardiac position, to changes in skin resistance, and to errors in standardization, one cannot analyze routine curves in minute detail. However, a comparison of such an analysis with one of simultaneous curves has convinced the author that little difficulty is usually experienced in assigning a proper name and time interval to the several deflections. While this technic leads to the terms "inverted Q, R, and S_2 and S_3, rather than adding confusion to the analysis, the method really clarifies and explains the occurrence of bizarre complexes, especially in Lead II, and carries us closer to the real significance of the slurring and notching we often see.

Fig. 2, *B*, is a reproduction of a curve taken with simultaneous Leads I and II, and I and III. This tracing in appearance has the character-

istics of Group A. It can be seen that R_1 + "S_3" = R_2; that R_1 + "R_3" $\neq$ R_2. The first upward deflection in Lead III may be seen as a slurring and almost a notching at the base of R_2. The explanation of this slurring then requires a study of the first upward deflection of Lead III, a wave which corresponds in time with the Q time phase of Lead I, and consequently is more truly an inverted Q_3. Since this small wave in Lead III, an upright wave corresponding to the Q time interval in Lead I, has no known clinical significance, one can realize why we have learned by experience that slurring near the isopotential line, as seen in Lead II, is of no diagnostic importance. The reduced height of R_2, as compared with R_1 and R_3, proves this complex to represent, at least in great part, the same electrical phenomenon. In general, the curves of Group A fell into this type and appear to be in a great part inversions of Lead III to form left axis deviation. Often there was a slight second positive deflection in Lead III and frequent inversions of P_3 and T_3, indicating entire inversions of this lead. Application of Einthoven's principles to these curves, however, shows that the complexes do not always add. This is due to a slight phase difference of the R spikes. That is, the waves of Lead III do not represent precisely the same time interval. Usually the inverted R_3 lags behind R_1, that is, it encroaches upon the S segment not only in its peak, but in a widening of the upstroke. That the S time interval is only slightly represented, however, is evident in the absence of S_2, for with Einthoven's rule one would expect an unopposed S_3 to make evident an S_2. This is precisely the case in the curves of Type D. A reproduction of another simultaneous curve (Fig. 2, *C*) demonstrates the effect of the S element in Lead III upon Lead II. In the present analysis of tracings, I have used the presence of S_2 as distinct evidence of the presence of an important S element in the downward deflection of Lead III. At times the absence of S_2 in the presence of S_3 is entirely due to a slurring down of R_1 with elevation above the base line during this time phase. When S_2 appeared to represent the same phenomenon as S_1, the curve was placed in Group A and not Group D. Proger and Minnich were unable to explain the presence and significance of S_2. It appears from this analysis that the solution lies not in the explanation of S_2 but in the explanation of S_3.

Of interest here, too, is an explanation of the notching of R_2 in curves of Group B, especially when the second positive deflection is of great size (Fig. 2, *D*). The notching of the downstroke of R_2, occurring in the S time interval, represents the effect of the electrical phenomenon describing the second positive deflection of Lead III. Similarly in curves with a less prominent deflection in Lead III the downstroke of R_2 appears as a slight thickening with irregularities identical with those of the wave in Lead III. The QRS width in Lead II can be seen to be increased over that of Lead I to include this time interval. The same analysis holds for Lead II and the upward deflection of Lead III in

curves of the "Q_3" type. This wave occurs at the time interval corresponding to the second positive deflection in curves of Group B. Yet this wave, representing simultaneous and apparently comparable phenomena in each type of curve, is called R in one case and goes unnamed in the other. This wave, as will be seen presently, appears more characteristic of "Q_3" types of curve than is the Q-wave itself.

Further application of the above method of analysis to the Q_3 type of curve described by Pardee discloses difficulties in interpretation. In none of the tracings of this type in the present series did "Q_3" + Q_1 = Q_2. "Q_3," in a large part, occupied the time interval of R_2, i.e., R_2 equaled more closely R_1 + "Q_3," indicating that the so-called Q_3 in this type of curve represented more closely the time interval of R_1 than Q_1 or Q_2. In many cases the downstroke of "Q_3" began in the Q_1 time interval so that the "Q_3" represented a wave occupying both the Q and R time intervals of Lead I. In these curves a Q_2 was always present unless the upstroke of R_1 included this interval with a positive potential. Others of the "Q_3" type of curves appeared identical with those of Group B and, in two cases, of Group A, except for the absence of the first small upward deflection in each instance. A review of the literature indicates that Shookhoff and Douglas[16] have also noted these changes. They have noted also that as Q_3 becomes larger, "R_3" becomes smaller, and "S_3" disappears; and the R_3 corresponds in time to S_1 and represents the same ventricular activity, as I have stated above. Furthermore, in normal electrocardiograms they found that a small Q_3 invariably corresponded to $Q_{1 \text{ and } 2}$, indicating, with the above two types of "Q_3," three possible groups: (1) those corresponding to Q_1 and Q_2, (2) those corresponding to Q_1 and part of R_1, and (3) those corresponding to R_1 in time. I agree, therefore, with the statement of Shookhoff and Douglas that the theories of Lewis and Wilson relative to the inscription of the normal Q_3 may apply only in part to the Q_3 of Pardee. The Q_3 of Pardee can hardly represent always the electrical phenomena of a definite portion of the cardiac musculature. That it may represent occasionally an unusual degree or type of cardiac displacement (rotation about the cardiac or bodily vertical axis) is evidenced by the infrequency with which it is met in normal individuals. Of types of axis deviation due to cardiac displacement, Group A seems to represent that of minor degrees, Group D that of a more marked degree, then Group B, and lastly Group C (Pardee). The percentages of diseased patients in these groups are 48.4 per cent, 71 per cent, 72.5 per cent and 85 per cent, respectively. One would expect that, were such curve types possible in health and disease, the less frequently one occurred in health, the more frequently proportionately would it be found in disease, and that hypersthenic patients falling into Group A in health might, with cardiac hypertrophy, change to one of the other types.

The remaining two distinct types of curves represent configurations which I have not met in patients with obesity and the hypersthenic habitus except in the presence of disease.

In Group E, a determination of the electrical angle of the R time interval indicates the presence of a positive angle, while that of the S time interval, a negative angle. This group is not, in a true sense, left axis deviation even though the major deflection is upward in Lead I and downward in Lead III. The height of R_2 distinguishes this fact at a glance. I have, however, included this group because of its resemblance to left axis deviation and because it illustrates clearly the differentiation between a true R- and a true S-wave in Lead III. This group always displayed an S_2 which was smaller than S_3, due in part to the fact that the S_1 interval was sometimes above the isopotential line. In this group the major downward deflection was almost entirely S_3, in contrast to Group D, in which the wave represents in part both R and S.

One also notes that as the S-wave becomes more dominant, it is found in a higher percentage of patients who are diseased. In the present group 21 (86.4 per cent) of 23 patients were definitely diseased. Of the remaining two, one had no clinical evidence of any type of cardiovascular disease. The other, a woman aged sixty-two years, showed evidence of peripheral arteriosclerosis with trophic skin changes and had a persistent blood pressure of approximately 158/82 and mild dyspnea on exertion. However, no objective signs of cardiac disease could be elicited.

In classifying this group care must be taken to rule out records with a prominent S_3 which approaches but does not exceed R_3. Those tracings in which S_3 did not exceed R_3 in all phases of normal respiration were also excluded. S_1 was not noted in this group. Inverted T_{1+2}, as noted in Fig. 1, *E*, occurred five times in this group.

As with Group E, curves of the type of Group G were found in no normal patients of the hypersthenic habitus, and I am able to ascribe neither of these types to changes in cardiac position alone. Lead II of Group G shows an entire inversion of the R time phase. Correspondingly the R and S phases of Lead III are downward. The apices of the major deflections in Leads II and III lag slightly behind the apex of R_1. The initial upward deflections of Leads II and III correspond in time to Q_1, and, in curves displaying Q_1, Q_1 plus Q_3 was seen to equal Q_2. Eight of the nine patients with this type of curve were definitely diseased. The remaining patient was a twenty-two-year-old medical student whose history, physical examination, and roentgen ray study were all negative for heart disease.

SUMMARY

In 431 records showing the major deflection upward in Lead I and downward in Lead III, the QRS configuration in 419 could be grouped into seven distinct types. While four of these types (A, B, C, D) appear to occur in various degrees and types of cardiac displacement, the frequency with which disease accompanies them varies greatly, especially with changes in the Q and S components. Other types of curves (E and G), apparently not related to cardiac displacement, appear much more frequently in diseased than in normal individuals. However, a larger series of these curves is necessary in order to evaluate them accurately. Group E does not rightfully fall into the group of left axis deviation.

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ECTOPIC TACHYCARDIA, AURICULAR IN ORIGIN, OF UNUSUAL DURATION*

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IT IS well known that the duration of paroxysmal auricular tachycardia is usually brief and is characterized by an abrupt onset and sudden cessation.

Recently we have had the opportunity of studying two patients whose electrocardiograms are identical with those considered characteristic of paroxysmal auricular tachycardia. In one of these patients a cardiac rate of approximately 140 per minute has been present nearly continuously for forty-three years; in the other patient a rate of 120 probably has persisted for ten years.

Paroxysmal auricular tachycardia was first described by Bristow[1] in 1888. In 1899 Bouveret[2] definitely separated paroxysmal tachycardia from the confused group of cases with simple sinus tachycardia. Vaquez[3] stated that the term "paroxysmal" is somewhat "artificial," as the "various attacks may be long or short; it is not its duration but the manner of evolution that should be considered." The disorder may occur in apparently normal individuals or in those with diseased hearts. It is not known whether hidden pathological lesions in the auricular musculature, abnormalities of the cardiac nerves, or lesions in the central nervous system initiate an attack. Usually there is an abrupt onset of tachycardia with regular beating of the heart (the rate is usually between 120 and 200). Some patients are able to carry on their occupations, while others may be affected by precordial pain, anxiety, and dyspnea. In prolonged attacks, especially in patients with organic heart disease, congestive failure and occasionally death ensue. In the average case, however, there is little dyspnea or discomfort in spite of the extremely rapid heart rate.

Lewis,[4] in discussing the duration of paroxysmal tachycardia, stated, "The attack, except in the very rarest instances, does not last beyond ten or fourteen days." White[5] remarked that the duration of paroxysmal auricular tachycardia was usually "a few seconds or a few minutes, sometimes occurring but once and sometimes repeatedly over a short space of time (a few days or weeks)."

Wilson and Herrmann[5] reported a case of ectopic tachycardia with the history of accelerated pulse of fifteen months' duration. Normal rhythm could be established for brief periods in this patient by digitalis administration and voluntary increase of intraabdominal pressure.

Speroni and Rey[6] described a patient with an electrocardiogram demonstrating paroxysmal auricular tachycardia, who had suffered re-

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peated attacks for twenty years. Autopsy showed the cause of death to be acute yellow atrophy of the liver. There was also rheumatic heart disease.

We have had the opportunity to observe two patients with auricular tachycardia of remarkable duration and have thought it worth while to describe these cases in some detail.

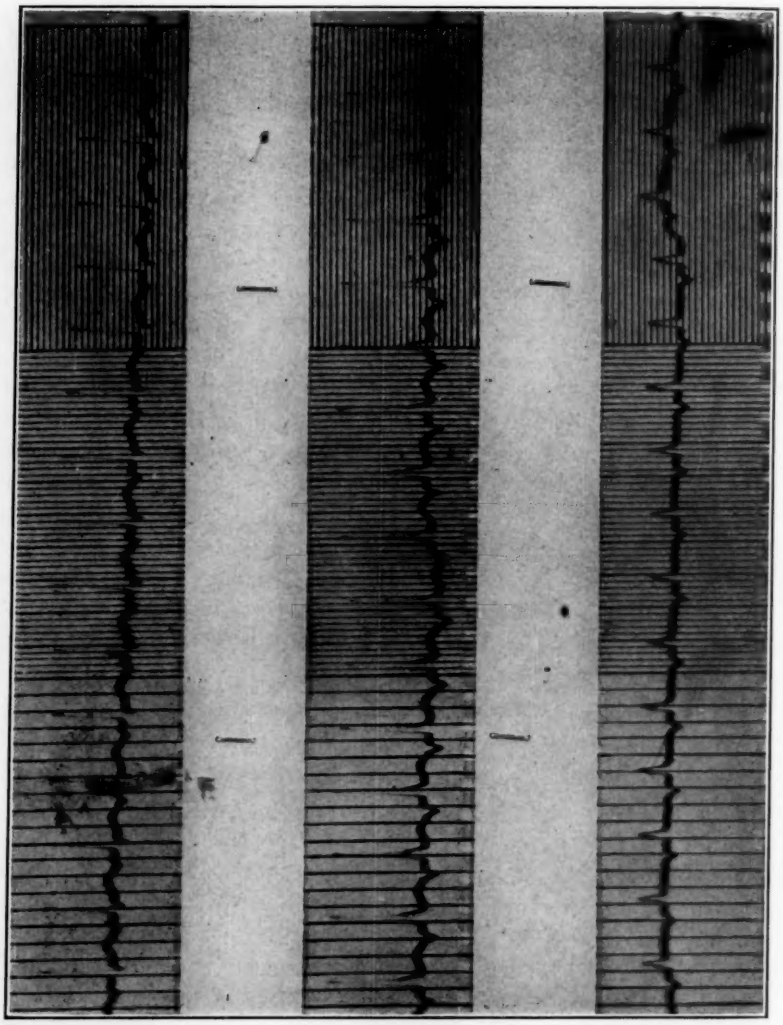

Fig. 1.—May 22, 1933. Tachycardia of auricular origin. Rhythm regular.

REPORT OF CASES

CASE 1.—Mr. A. A., aged fifty-nine years, presented himself May 22, 1933, complaining of an old sacroiliac strain and discomfort in the right side of the abdomen. During the examination he remarked that he had had rapid heart action for a number of years, but that he did not have any symptoms referable to his heart. He was leading an active business life and played golf frequently without

discomfort. On further questioning it was ascertained that in 1893, at the age of nineteen years, following an attack of malaria, he developed a "fast heart." He recalled that his pulse rate was 132 at that time. *He was kept in bed for six months* and was given digitalis part of the time, *but the rapid heart action continued at the same rate.*

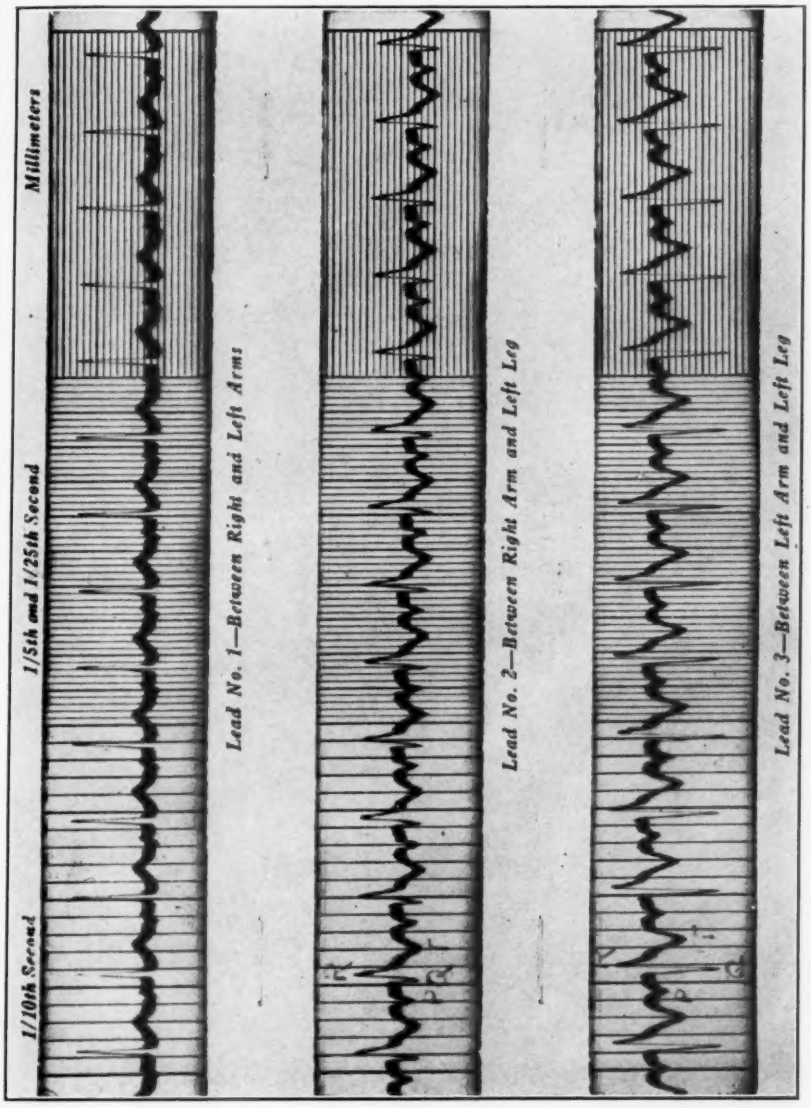

Fig. 2.—May 17, 1935. Auricular tachycardia, rate 140, four weeks after a characteristic attack of coronary occlusion. The elevated RS-T segments and negative T-waves in Leads II and III are suggestive of infarction of the posterior portion of the left ventricle.

Subsequently there were no symptoms referable to the heart, but, after failing to pass a life insurance examination, he consulted Dr. Alfred Friedlander, of Cincinnati, on January 29, 1916. The findings at that time showed the heart size to be within normal limits, the rate was 132, and rhythm was regular. The blood pressure was 124/74. On Feb. 24, 1919, the heart rate was 132, and on March 17, 1919, the rate was 124.

Following the examinations in 1916 and 1919 he had felt well. There was no palpitation, precordial pain, or dyspnea during the intervening years. He believed that the rapid heart rate had persisted continuously since its onset.

The examination on May 22, 1933, showed that the patient was a stocky man of fifty-nine years, weighing 155 pounds and measuring 5 feet 4½ inches in height. The heart borders were 10 × 4 cm., R.S.D. 6 cm. The heart rate was 174, regular,

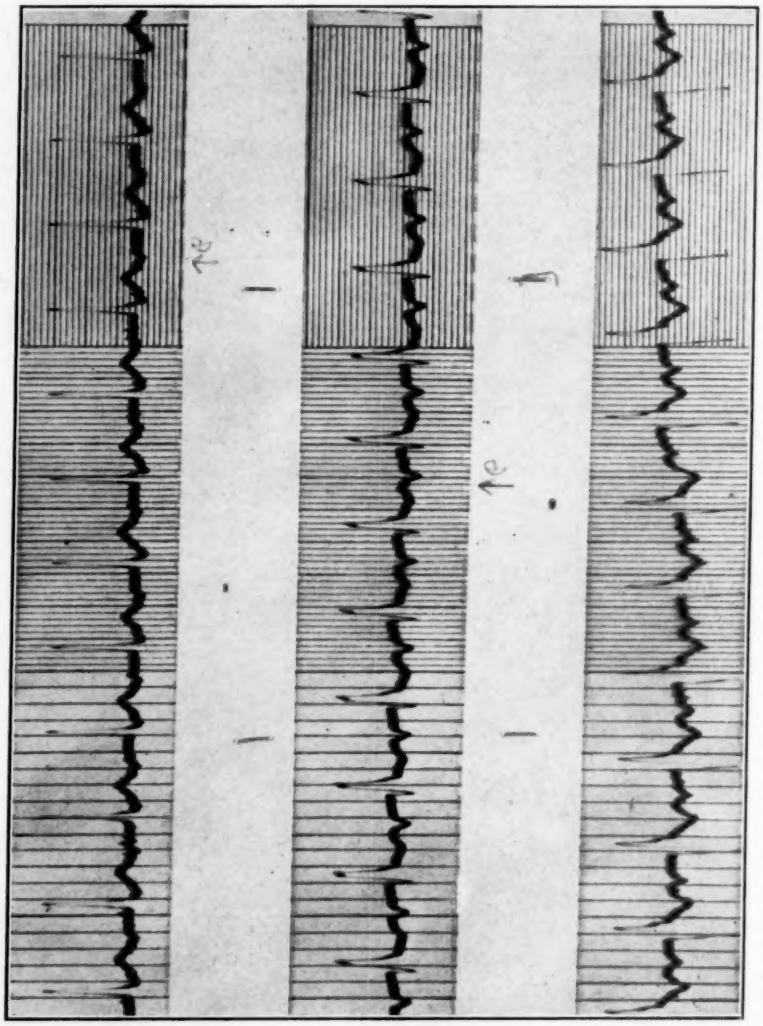

Fig. 3.—Nov. 25, 1935. Rate of auricular tachycardia now only 120 with prolonged conduction time (P-R 0.24 sec.). There is the prominence of Q_2 and Q_3 so often associated with previous infarction. The inverted P-waves are superimposed on negative T-waves in Leads II and III.

no murmurs were heard; A_2 was greater than P_2. Blood pressure was 170/90. The chest was clear to percussion and auscultation. The abdomen was soft; the liver edge was felt below the costal margin. The spleen was not felt. An electrocardiogram was made May 22, 1933, and is reproduced in Fig. 1. It is characteristic of paroxysmal auricular tachycardia, the rate 160. A teleroentgenogram of the heart was normal.

The patient was hospitalized and, while in the hospital, a horseshoe kidney was demonstrated with evidence of infection in the urinary tract. There was also an obstruction, reported as characteristic of the stricture described by Hunner, in the

right ureter. No stones were demonstrated. While he was in the hospital, the heart rate was 172, the rhythm regular, the blood pressure 130/90. *A trial of quinidine, 5 grains every six hours for five days, did not alter the rate. Full digitalization at this time did not affect the rate.*

In June, 1934, he returned because of abdominal distress. No abdominal abnormalities were found. The pulse at this time was 156.

On Dec. 7, 1934, the patient was again seen, this time reporting that he felt well. The heart rate was 156. After an exercise test the rate was 168, and there was no abnormal dyspnea. After he was recumbent for five minutes the rate was 142. An electrocardiogram was nearly identical to the record of May, 1933, although the rate had decreased to 140.

On April 20, 1935, he developed a coronary occlusion and was under the care of Dr. Mendeloff, of Charleston, W. Va., his family physician. Examination at that time showed the blood pressure to be 126/84 and the heart rate 72 and regular. The next morning the pulse was 84 and the blood pressure 90/68. On the second morning the pulse was 108 and the blood pressure 108/74. Later the heart rate was between 120 and 130, and the blood pressure was 100/60, and occasionally the heart action was irregular. An electrocardiogram made four weeks after the coronary occlusion is most interesting. It is shown in Fig. 2, and reveals the previous type of ectopic auricular tachycardia. The record also shows abnormal prominence of Q_3 and high deviation of the RS-T segment in Leads II and III with cove-shaped T-waves. These findings are usually associated with the obstruction of a major branch of the coronary artery supplying the posterior basal area of the left ventricle.

On Nov. 25, 1935, the man presented himself for an examination, which revealed the heart rate to be 120, regular, and the blood pressure 150/80. A blowing systolic murmur was heard at the apex; the murmur was not transmitted. A_2 was greater than P_2. He reported that he had had two attacks of "asthma" about a month previously, but none since, and that he felt quite well again. An electrocardiogram, Fig. 3, presents rather characteristic evidences of a former coronary occlusion and the same interesting tachycardia of auricular origin.*

TABLE I

CASE 1. CARDIAC RATE SINCE ONSET OF TACHYCARDIA AS DETERMINED CLINICALLY OR ELECTROCARDIOGRAPHICALLY

DATE		RATE	
	1893	132	(Rate not influenced by rest at home for six months)
January	1916	132	
February	1919	132	
March	1919	124	
May	1933	160	
June	1934	156	
December	1934	140	
April	1935	72	(Following coronary occlusion)
May	1935	140	
November	1935	120	

CASE 2.—The patient (O. K. C.) was referred in March, 1934, by a gynecologist because of a rapid pulse. She had consulted the gynecologist because of symptoms associated with retroversion of the uterus. The patient, a woman aged twenty-seven years, believed that her heart rate had been rapid for approximately ten years. It had "worried" her doctors at her school. The only symptoms referable to the heart were palpitation when lying on the left side, frequent sighing, and slight pretibial edema in hot weather. The patient was a rather nervous young

*In the early part or June, 1936 (after this paper was presented for publication), the patient died in an attack of dyspnea.

woman who did not appear to be ill. She was slightly under her ideal weight. The temperature was 97° F., blood pressure 100/60, pulse 120. The physical examination was essentially negative except for the presence of a soft systolic murmur at the apex of the heart. There was no enlargement of the heart, and the rhythm was regular. The lungs were normal. The liver and the spleen were not felt.

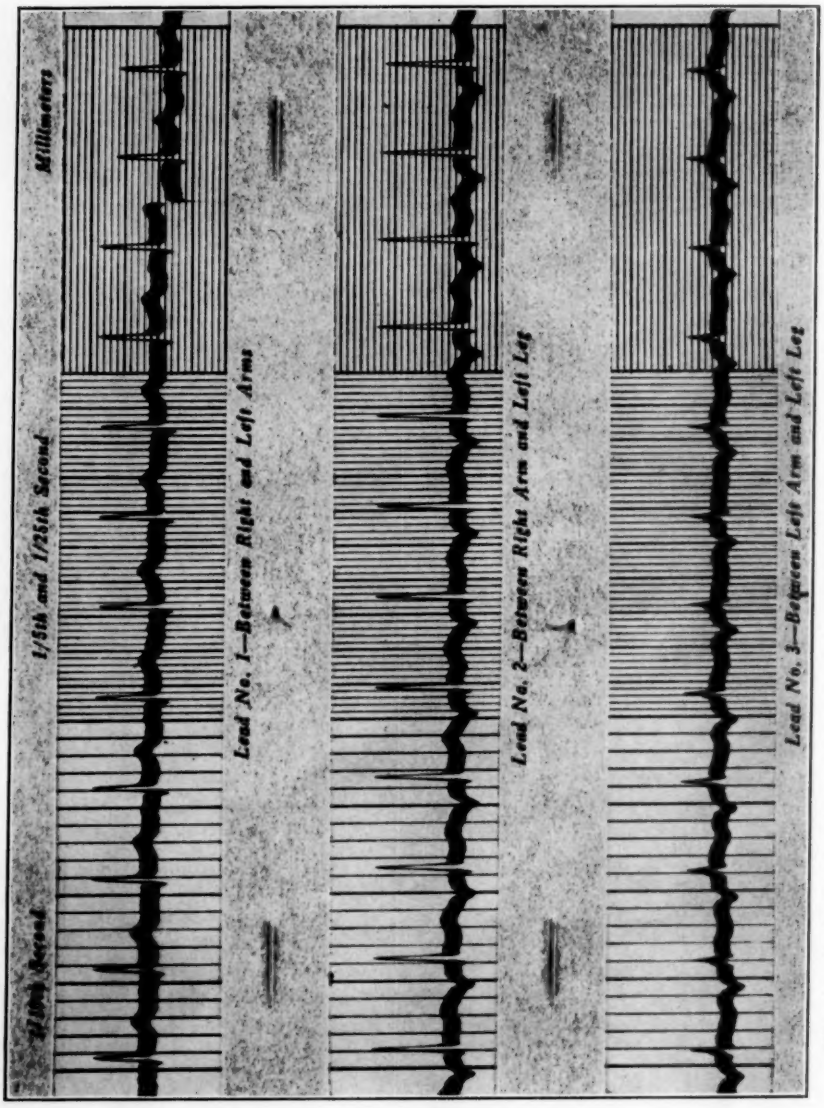

Fig. 4.—Auricular tachycardia. Rate 120. RS-T segment of Lead I is slightly high in origin.

There was no edema of the ankles. A teleroentgenogram showed the heart to be of normal size and configuration. The basal metabolic rate was -15 per cent. An electrocardiogram, Fig. 4, showed the characteristic evidence of paroxysmal auricular tachycardia, rate 120.

The patient was asked to count her pulse at two-hour-intervals and to keep a record of the results. She was assured of the harmlessness of the condition in the presence of a normal heart.

The rate persisted at approximately 120, save on the following morning, when she counted the pulse at 76 immediately on awakening. In a few minutes the pulse returned to its usual rate of 120.

Three weeks later one of us (J. McG.) had the opportunity to see the patient. The pulse was 120 and regular. As she was leaving the city permanently that afternoon, she refused to have another electrocardiogram made. Subsequent efforts to secure information regarding the heart rate have been unsuccessful, but the patient has recently successfully gone through a pregnancy.

DISCUSSION

Two patients have been described with ectopic auricular tachycardia of many years' duration. In neither case was there cardiac hypertrophy or evidence of myocardial insufficiency. In both patients the electrocardiograms were identical with those universally considered characteristic of auricular paroxysmal tachycardia.

Tachycardia, of sinus origin, with rates of 120 or over, rarely is encountered save in the presence of febrile illnesses, thyrotoxicosis, auricular flutter, or neurocirculatory asthenia. The clinical and electrocardiographic findings exclude any such factors in our cases. As to the influence of normal sinus tachycardia of equivalent rate and duration upon cardiac function, clinical experience with cases of neurocirculatory asthenia perhaps affords the best basis for comparison. However, in such cases there is always relative slowing during sleep. The possibility of regular reversion to normal rhythm during sleep in our second case must be considered.

Certain conclusions seem obvious: (1) that cardiac rates of 150 or below are not dangerous per se, even when existing for years, in the presence of an otherwise normal heart; (2) that the term "paroxysmal auricular tachycardia" in the sense of *transient* cannot always be employed accurately if the diagnosis is made from the electrocardiogram alone.

SUMMARY

Two instances of ectopic auricular tachycardia of many years duration have been described.

As far as can be ascertained, these cases are unique.

In neither patient was there evidence of myocardial insufficiency as a result of the tachycardia. One of the patients developed a coronary occlusion associated with temporary slowing of the heart rate but survived the attack despite the reappearance of tachycardia.

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CARDIODYNAMIC AND ELECTROCARDIOGRAPHIC CHANGES IN NORMAL PREGNANCY*

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MUCH has been written about the heart in pregnancy. Most of the literature deals with the clinical aspects of the condition, and it is generally felt that patients with Class I and Class II† A cardiac conditions do well during the course of a pregnancy, and patients with II B and Class III cardiac conditions do poorly. MacKenzie,[1] in his book, *Heart Disease and Pregnancy,* treats this subject almost entirely from the clinical viewpoint and deals with it for the most part in generalities. It was with the hope of establishing more definite criteria that this work was started. It soon became evident, however, that not enough was known about the cardiocirculatory changes in the normal pregnant woman for any conclusion to be drawn with respect to the changes in those pregnant women having heart disease. Although isolated phases of this problem have been studied and reported, complete correlated cardiodynamic and electrocardiographic studies are lacking.

Some of the more pertinent results reported with regard to the electrocardiographic findings in pregnancy are as follows: Jensen and Norgaard[2] reported a tendency toward left axis deviation in the early months of pregnancy with return toward the normal in the latter months of pregnancy. Smith[3] reported a left axis deviation in the eighth month of pregnancy with a return toward the normal just before delivery of the child. Konki[4] reported left axis deviation and T-wave inversion in Lead III during the latter part of pregnancy with return to the normal after delivery. Carr and Palmer[5] reported that the axis shifted to the left during the first two trimesters of pregnancy and then tended to shift to the right during the eighth and ninth month of pregnancy. Carr, Hamilton, and Palmer[6] in another paper stated that the development of a Q_3 was probably an indication of a transverse position of the heart during the course of the pregnancy and not a reliable sign of heart disease. Feldman and Hill[7] taking electrocardiograms on thirty-six normal pregnant women at the eighth and ninth months and comparing these with electrocardiograms taken after delivery concurred with the above mentioned findings.

Nowhere in the literature could a study of the changes occurring in Lead IV during pregnancy be found.

There is even a greater lack of published correlated cardiodynamic findings occurring during the course of pregnancy. Runge[8] found that

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†Classification of Heart Disease, American Heart Association.

the venous pressure in a nongravid woman in the arm and leg was equal. During pregnancy the venous pressure in the leg was higher than that in the ulnar vein, and in the puerperium the venous pressure in the legs dropped far below the venous pressure in the median vein. Spitzer[9] concluded that the circulation time remained within the limits of high normal during the course of pregnancy in the normal woman. Alward[10] taking vital capacities on standing patients reported a gradual reduction during the last month of pregnancy with a gradual return to normal limits at the tenth day of the puerperium. Stander and Cadden[11] found a steady increase in the cardiac output from the fourth month of pregnancy amounting to over 50 per cent of the normal value as the pregnancy advanced, with a return to the normal by the third week of the puerperium.

The reason for the lack of correlated data with regard to the cardiocirculatory changes during the course of pregnancy becomes obvious when viewed in the light of our experience. Forty-four normal pregnant women were studied.

With every possible effort we were able to complete our observations in only nineteen cases. Examinations of some patients were discontinued because of development of urine abnormalities or marked varicosities. Others refused to return after four to six months of observation because of the rather arduous nature of the examination. We found it almost impossible to obtain patients in the first and second months of pregnancy. This lack of control observation was negated by the performance of a follow-up examination on the patients six to eight weeks after their delivery.

METHOD OF PROCEDURE

Patients were seen as early as possible during the course of their pregnancy. None was taken for examination after the fourth month. All women selected were normal. Patients who had, or who developed, positive serology, abnormal urinary findings, or abnormal blood findings were excluded.

At the time of first examination a complete history, physical examination, and an x-ray film of the chest were taken. A record was made of the pulse rate, respiratory rate, and blood pressure. Then, a four-lead electrocardiogram was obtained, and vital capacity, intravenous pressure, and circulation time were measured. Care was taken to have the patient rest for thirty minutes before the procedures were started, and the intravenous pressure and circulation time were measured in the order named at the end of the examination so as not to influence the other cardiodynamic findings.

Lateral and anterior x-ray pictures of the chest were taken at the time of deep inspiration in order to rule out, as far as possible, apparent enlargement of the heart due to a transverse position of the organ. The pulse rate, respiratory rate, blood pressure, and vital capacity examinations were recorded with the patient in a sitting position, this being a compromise between the supine and standing positions.

The fourth lead of the four-lead electrocardiograms was taken with the right-arm electrode placed in the fourth interspace just to the left of the sternum and with the left arm electrode placed on the left leg. The authors agree with Katz and Landt[12] that the fourth left intercostal space should be the site of choice for the

right-arm electrode because of the variability of the location of the apex of the heart in different patients. Furthermore, it can readily be seen that an apical fourth lead electrocardiogram would tend to negate any findings with regard to axis shift as the pregnancy advanced. Likewise, we feel that the left leg should be the site of choice for the left arm electrode or indifferent electrode because, as Wilson and his associates[13] have shown, the fourth lead of the electrocardiogram is not appreciably altered by this method. The above mentioned positions of the electrode for the fourth lead are of distinct advantage inasmuch as respiration will not tend to cause a slippage of the electrodes as is encountered when the anteroposterior chest technic is used. The intravenous pressures were taken after the method of Griffith, Chamberlain, and Kitchell.[14] The region of the right cubital vein was anesthetized with 1 per cent procaine solution so as to obviate the pain and the consequent reflex reaction of the circulatory system produced by the injection of the manometer needle. The intravenous pressures were measured with the manometer needle in the cubital vein with the patient in a horizontal position, care being taken to level the vein and the manometer zero reading with the midaxillary line. The midaxillary line is usually accepted as being at the level of the right auricle. After the completion of this procedure the manometer was disconnected from the needle, and a syringe containing 5 c.c. of decholin was attached to the needle. This was injected rapidly, and by means of a stop watch the elapsed time was noted for the appearance of a reaction in the form of a bitter taste in the patient's mouth. The reactions were clear-cut and the grimace of the patient, the signal agreed upon, immediately marked the appearance of the bitter taste. We used decholin because we wished to correlate our work with that of Spitzer,[9] who originally investigated this phase of the problem.

Each patient was seen at monthly intervals following the initial examination and the previously described procedures were carried out except for the x-ray examinations which were made at the time of the initial visit; at the seventh to eighth month of pregnancy and six to eight weeks postpartum. A complete check examination was done six to eight weeks following the delivery. These patients also received monthly examinations in the prenatal clinic, and thus we were furnished with additional evidence as to the condition of the individual.

OBSERVATIONS

History.—The ages of the nineteen patients studied ranged from seventeen to thirty years. None of them had been seriously ill during their lives, and their past histories were relatively unimportant. They all had had diseases of childhood, but none was left with any residuals. During the course of their pregnancies no untoward complaints were registered. Every one of them stated that from about the fourth month on they noticed progressive tiredness and progressive shortness of breath on exertion. All of the patients developed urinary frequency and nocturia of one to three times per evening from about the fourth month of pregnancy until time of delivery. We were inclined to view the frequent voiding in the light of a decreased bladder capacity as a result of compression by the enlarging uterus. Later in this article we present evidence which shows that a burden is placed on the cardiocirculatory system by the advancing pregnancy which in the normal case is compensated for by the physiological readjustment of that and allied systems. We, therefore, agree with the fundamental concept of MacKenzie,[1] which would explain the symptoms resulting from exercise as being the

effect of another burden superimposed on a system which had been working to the maximum of its functional reserve. From the seventh month of pregnancy until time of delivery, six of the patients gave a history of slight edema of the ankles toward the close of the day. This edema did not appear unless the patient was on her feet for a long period of time (six to eight hours) and was interpreted by us as being the result of uterine pressure on the common iliac veins.

Physical Examination.—The changes produced by the advance in pregnancy were of particular interest as evidenced by the physical findings. In all of the nineteen cases there was a progressive increase in accessibility of the right ventricle as noted by palpation over the precordium. Associated with this observation was the fact that, as the pregnancy advanced, the pulmonic second sound became progressively more distinct and the aortic second sound diminished in intensity. Actual statistics of our cases show that the pulmonic second sound became much louder than the aortic second sound in the majority of cases (fifteen), slightly more distinct in three cases, and equal to the aortic second sound in one case. The above findings had their inception about the fourth month of pregnancy, became more manifest until the seventh month, and then remained stationary or decreased slightly until time of delivery.

The increased intensity of the pulmonic second sound could be expected in view of the increased accessibility of the right ventricle to palpation and our x-ray evidence of the encroachment of the right ventricle on the anterior clear space. That the increased pulmonic second sound was not due to increased pressure in the lesser circulation can be indirectly inferred from the intravenous pressures obtained which showed no elevation. The decreased aortic second sound is easily understood when one views the drop in blood pressure associated with the advancing pregnancy.

A systolic murmur was heard over the base of the heart and was localized over the pulmonic area in fourteen of the cases. It was usually first heard in the third to the fourth month, became progressively louder until the seventh to eighth month, and then remained stationary or decreased slightly in intensity until time of delivery. At the time of post-partum examination the systolic murmur, like the other cardiac abnormalities, had disappeared. Two cases developed a split second sound at the base during their pregnancy. In the nineteen cases studied, no murmurs were heard at the apex. One case (Mrs. B. C., No. 20) had a palpable thrill accompanying the systolic murmur at the base. The origin of the systolic murmur at the base is not well understood. The fact that it tended to disappear with deep inspiration may point to a kinking of the pulmonic artery as a causative factor, the kinking being relieved by the descent of the heart with the diaphragm on deep inspiration. On the other hand, the systolic murmur at the base may be of

cardiorespiratory origin. This last interpretation does not explain the pulmonic thrill found in one of the cases reported and two others not included in this series.

Table I condenses these findings.

TABLE I

CASES	SYSTOLIC MURMUR PNEUMONIC AREA	ACCENTUATED P-2	DECREASED A-2	ACCESSIBLE RT. VENT.	HISTORY OF EDEMA OF ANKLES	
1	+	+	+	+	+	
2	+	+	+	+	+	
3	+	+	+	+	−	
7	+	+	+	+	−	
8	+	+	+	+	−	
10	+	+	+	+	−	
11	+	+	+	+	−	
15	+	+	+	+	−	
17	+	+	+	+	+	
18	+	+	+	+	−	←Split second sound at base
20	+	+	+	+	+	←Systolic thrill pulmonic area
22	+	+	+	+	+	
23	+	+	+	+	+	
24	+	+	+	+	−	
12	−	+	+	+	−	
19	−	+	+	+	−	←Split second sound at base
21	−	+	+	+	−	
27	−	+	+	+	−	
29	−	+	+	+	−	

Blood Pressure.—If one can consider the final blood pressure taken, at the time of follow-up examination, six to eight weeks following delivery, as being the average normal, it will be noted that the systolic pressures fall in a linear fashion during the first four months of pregnancy. The average fall for nineteen cases was 13 mm. of mercury. The same is true of the diastolic pressures, the average fall for the nineteen cases during the first four months of pregnancy being 17 mm. of mercury. From the fifth to the seventh months of pregnancy the average systolic and diastolic pressures do not change appreciably. From the seventh to the beginning of the ninth month there is a slight but definite rise as shown by the average systolic and diastolic pressures. At the time of post-partum examination the average systolic pressure had risen 11 mm. mercury and the average diastolic 14 mm. mercury. If one scrutinizes the data, one will find that the trend of both systolic and diastolic pressure in each individual case absolutely parallels the reported average trend. A definite explanation for the lowered systolic and diastolic pressures during the height of the pregnancy can be found if one takes into account the enormous blood reservoir created in the pregnant uterus and compares this condition to cases in which slight degrees of splanchnic

dilatation occur. When the process of lightening occurs, the blood reservoir is decreased as a result of pressure exerted by the confines of the pelvis, the rise in systolic and diastolic pressures during the eighth and ninth months being proportioned to this dynamic effect. When the uterus is emptied, the blood reservoir disappears with the delivery of the placenta and six to eight weeks post partum the pressure is again at the norm.

Pulse and Respiratory Rates.—The pulse and respiratory rates gradually increase until the seventh month of pregnancy. From the seventh to the eighth month the pulse rate continues to rise while the respiratory

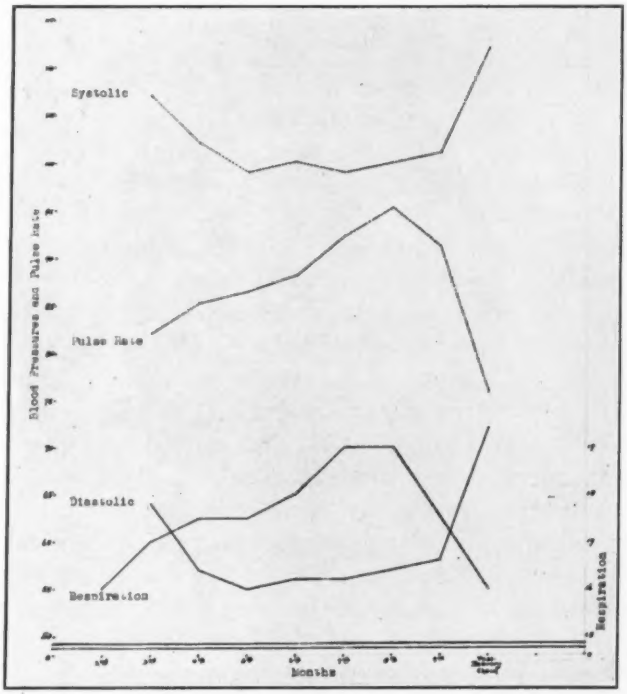

Fig. 1.—Graphic representation of systolic and diastolic blood pressures, pulse rates, and respiration rates through the months of pregnancy.

rate levels off. From the eighth month the trend of both rates is sharply downward until at the time of examination after delivery the average pulse rate was 72 per minute and the average respiratory rate 16 per minute. The trend of the pulse rate and the respiratory rate is an index of an attempt to compensate for an embarrassed circulation. The trend of these two rates again fits in with the picture seen in slight degrees of splanchnic dilatation.

Figure 1 graphically illustrates the trends of the systolic and diastolic pressures and the pulse rate and respiratory rate during the course of pregnancy.

Intravenous Pressures.—In general, intravenous pressures had a tendency to start at a fairly high level (80 to 100 cm. of water) in the early months of pregnancy, then decrease until about the sixth to the seventh month and then increase until the time of final examination. Frequently they did not return to the level of the previous highest pressure and in three women remained at the level found during the ninth month. From the data one is justified in stating that in the majority of cases the intravenous pressures are at their lowest about the sixth to the seventh month. The range of the intravenous pressures in all cases did not exceed 48 to 110 cm. of water. If the initial venous pressure was high, the drop during the sixth to the seventh month did not reach the low levels found at the same period in those cases starting with a relatively low initial intravenous pressure. Thus we see that the intravenous pressures fall within the high normal ranges (40 to 140 cm. of water), established by George C. Griffith and his associates,[15] who used the same technic. The tendency of the intravenous pressures to drop during the middle month of the pregnancy seems to coincide with the drop in blood pressures. The tendency toward a slight rise in the intravenous pressures from the seventh to the ninth month also roughly parallels the absolute trend of the blood pressures. However, the trend of the intravenous pressures throughout pregnancy is not nearly as definite as that of the blood pressures. Again one can see the phenomenon of the changing volume of a large blood reservoir mirrored to some extent in the intravenous pressure findings.

Circulation Time.—The circulation time ranged from nine to sixteen seconds in the nineteen cases studied. The majority of patients ranged from ten to fourteen seconds. There was no definite trend throughout the course of pregnancy. These findings agree with work of Spitzer[9] and fall within the limits of normal. We feel that the relatively stationary circulation time is a resultant of the previously mentioned trends of blood pressure, intravenous pressure, pulse rate, respiratory rate, and cardiac output. It has been shown by Stander and Cadden[11] that from the fourth month of pregnancy to full term there is a steady increase in cardiac output, amounting to about 50 per cent of the normal. This increase in cardiac output again fits into the picture and may fully be accounted for by the increase in pulse rate without presupposing an associated enlargement of the ventricles.

Vital Capacity.—On the whole, the vital capacities on successive months did not show any definite trend during the course of pregnancy. To be sure, there was a monthly variation of 100 to 200 c.c. and in some few isolated instances there was a deviation of as much as 300 c.c. from the preceding month. These variations were in the nature of an increase or a decrease from the mean. For the most part the monthly variations in the vital capacities were not in excess of what one finds in a normal person from day to day.

At first we were of the opinion that the vital capacity of a patient would increase as the pregnancy advanced. Recalling Hoover's[16] work with regard to diaphragmatic excursions we expected this since the dome of the diaphragm is greatly elevated during the course of pregnancy. However, there is a marked increase in the intra-abdominal pressure. Therefore, any given vital capacity must be viewed as a resultant of these contracting forces. Increase or decrease of the vital capacity depends on which force is in ascendancy. This is in turn modified by the patient's position. From clinical and x-ray evidence there can be no doubt that the residual capacity of the lungs is greatly diminished.

X-ray Examination of Chest.—The anterior view of the chest showed elevation of the diaphragm from the fourth month on. It must be realized that the x-ray examinations of the chest were done at the height of a deep inspiration. These silhouettes show that during the middle months of pregnancy the diaphragm on both sides was elevated on an average of 2 cm., above the normal. At this time the oblique and transverse diameters of the heart showed a 0.5 cm. to 1 cm. increase over the normal size.

The corresponding lateral views, even at the time of deep inspiration, showed some degree of encroachment on the anterior clear space by the right ventricle. The average increase of the anteroposterior diameter of the heart in the nineteen cases studied during the middle months of pregnancy was about 1 cm., over the normal.

As the pregnancy advanced, the heart was pushed upward and forward. This was to be expected when one recalls that the heart rests for the most part on the left anterior slope of the diaphragm. X-ray silhouettes taken with the patient holding her breath in midtidal respiration showed a marked elevation of the diaphragm and a definite encroachment of the right ventricle on the anterior clear space. It is our opinion that the small increases noted in the various diameters of the heart during deep inspiration cannot be interpreted as being the result of the cardiac enlargement. We feel that they are an expression of a more transverse position of this organ as a result of the average diaphragmatic elevation of 2 cm., encountered at this time. This elevation of the diaphragm agreed with the results of Hynemann,[17] who found that during the early part of the third trimester the right side of the diaphragm was elevated on the average of 2 cm. and the left side of the diaphragm on an average of 2.1 cm. He also noted that the heart had assumed a more transverse position at this time.

In addition to these x-ray findings and their interpretation, our contention that the heart is not enlarged during pregnancy is further supported by the fact that a searching review of our cardiodynamic findings failed to give any evidence which a priori would demand cardiac enlargement for its explanation. In the first place the blood pressures, systolic

and diastolic, fall during the course of the pregnancy. The intravenous pressures, although remaining within the range of the normal, show a tendency to decrease. The rapid pulse rate precludes any increased filling of the heart per beat. We have pointed out that the increased cardiac output can be definitely explained on the basis of increased pulse rate. Finally, it can be inferred that there is no increase in the lesser circulation pressure, both from the reported intravenous pressures and from the fact that the magnitude of the decreased residual capacity of the lungs does not approach that necessary to cause an increase in the lesser circulation pressure.

The Electrocardiographic Changes.—The electrocardiograms of the 19 cases comprising this study can be divided into several groups. The types for the most part depend on characteristic or lack of characteristic changes in Lead III. When one views the records, one will find that for practical purposes Leads I and II remain unchanged throughout the course of pregnancy. From the position of the "pick up" electrodes with regard to the shifting heart, it can be readily understood why Leads

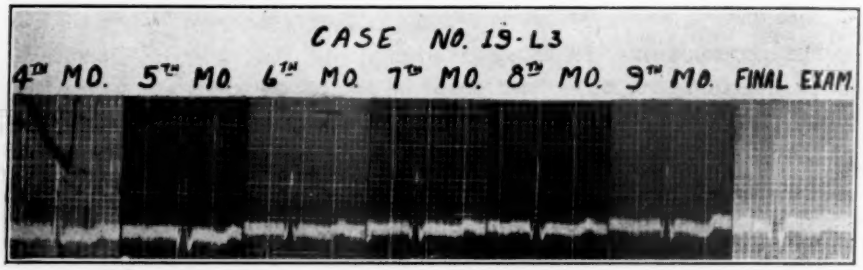

Fig. 2.

I and II tend to remain constant and why Leads III and IV show variations during the period of pregnancy.

Four cases may be automatically placed in Group I. They showed no appreciable changes with regard to P or QRS deflections throughout the course of the pregnancy. They did show a definite inversion of the T-wave which became apparent at any time from the fourth to the ninth month, which changed from month to month, and which became definitely positive at the time of the final examination. (Cases 2, 8, 17, and 19.) Case 19 shows a series of electrocardiograms characteristic of this group (Fig. 2).

Group II is composed of 12 cases. In general, these cases may be described as showing a tendency toward left axis shift (or actually showing a definite left axis shift).

For purposes of clarity it is necessary to further divide Group II into three subgroups. In Group II A there were six cases (Cases 3, 7, 12, 21, 23, and 27) whose electrocardiograms in Lead III primarily showed a decrease in voltage of the QRS complex (Fig. 3). This group showed

an attendant slurring of the QRS complex in some instances (Cases 3, 7, 23, and 27), and the development of an "ironed out" or inverted T-wave in all six cases. Two of the six cases (Cases 23 and 27) showed a small Q-wave at the time when the voltage was lowest (Fig. 4).

Case 3, which is typical of this group, lends further support to the belief that in this study a progressive lowering of the voltage is the first stage of a definite axis shift. At the eighth month when the QRS was at its lowest voltage and markedly slurred, a forced expiration which lifted the diaphragm higher, produced a definite inverted QRS complex in which the R-wave was absent (Fig. 5).

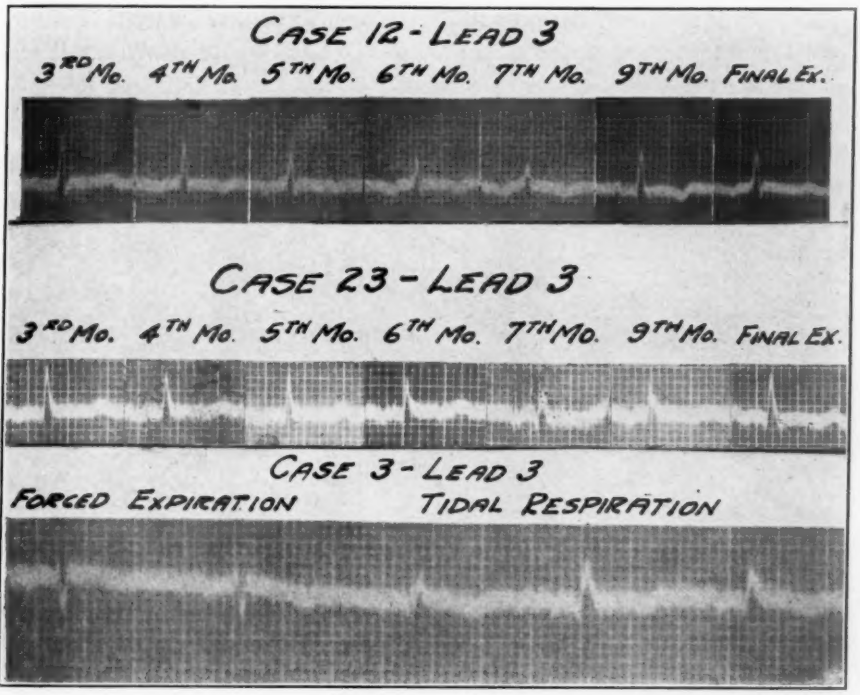

Fig. 3.

Fig. 4.

Fig. 5.

Group II B is composed of the remaining six cases. These cases present electrocardiograms that show definite left axis shift. Three of these cases (Cases 15, 18, and 22) developed the *W*-type of wave which in the early months of pregnancy appeared as a normal QRS complex with a small but definite Q- and S-wave. Case 15 demonstrated this type of change. All three cases presented a flattening or inversion of the T-wave some time during the course of the pregnancy, and slurring of the QRS complex (Fig. 6).

The other three cases (Cases 1, 20, and 24) showed the development of a left axis shift during the course of the pregnancy. All three of these had slurring of the QRS complex and two (Cases 1 and 24) show the usual alteration in the T-wave (Fig. 7).

Group III is composed of two cases (Cases 10 and 29) which are distinctly different from the rest. In the earlier months of pregnancy the QRS complex had a diphasic character with the initial Q deflection, although small, being larger than the R deflection. As pregnancy advanced, the voltage increased and the R deflection became larger than the Q until the eighth month of pregnancy, when the original Q deflection was represented by an upstroke of the R deflection, At the time of final examination the QRS complex was again diphasic, the Q being larger than the R. Both of these cases show the usual T-wave changes (Fig. 8).

Group IV was created because the final case (Case 2) could not be placed in any of the preceding groups. Lead III did not change appreciably throughout the pregnancy. The P-wave was inverted throughout the study. The initial deflection of the QRS complex was small and

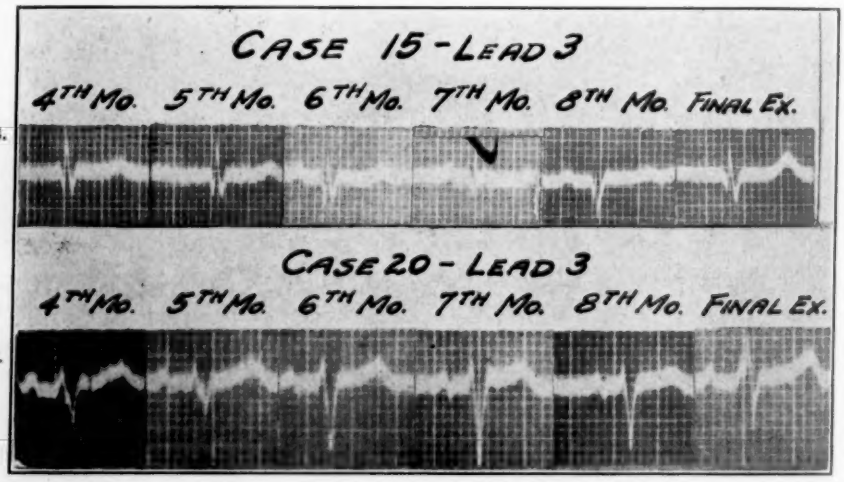

Fig. 6.

Fig. 7.

upright. The major deflection was down and inverted. Actually the QRS complex was diphasic, but it presented the picture of a definite permanent left axis shift.

The T-wave went through the usual changes and at the time of final examination it was diphasic in character. As far as we could ascertain, the patient did not have any heart disease and was perfectly normal (Fig. 9).

In all of the nineteen cases definite changes were noted throughout the course of pregnancy in Lead IV. For the most part these were shown by the shifting of the S-T segment, which had a tendency to change from a negative take-off to an isoelectric take-off and by the T-wave, which became diphasic in some instances, even upright and positive. The QRS complex frequently changed in amplitude during the course of the pregnancy. Quite frequently the initial Q deflection became smaller. Several of the cases showed definite slurring of the QRS complex. Cases 7, 19, and 21 showed these changes (Fig. 10).

The electrocardiographic changes can be explained for the most part on the basis of a left axis shift. Einthoven and his coworkers[18] have shown that the transverse position of the heart at the end of expiration is associated with a tendency toward, or with an actual, left axis deviation as noted in a standard three-lead electrocardiogram. Cohn and Raisbeck[19] have also shown that the left axis deviation in the electrocardiogram is associated with a greater transverse position of the heart and that right axis deviation tends to occur as the position of the heart becomes more vertical. Smith,[3] Konki,[4] Jensen and Norgaard,[2] Carr and

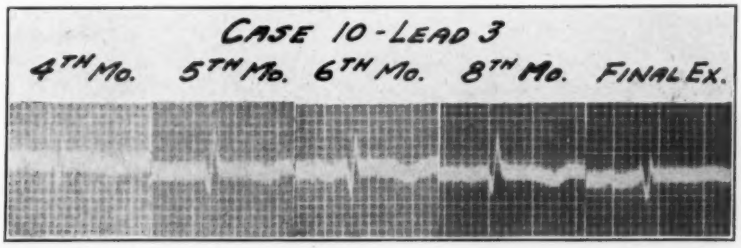

Fig. 8.

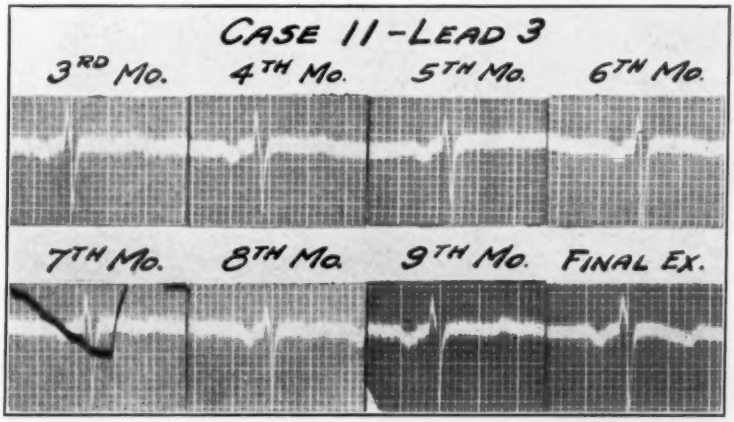

Fig. 9.

Palmer,[5] and Feldman and Hill,[7] from their studies of the conventional three-lead electrocardiogram taken of pregnant women, came to the conclusion that the changes observed are the result of left axis deviation. Feldman and Hill studied electrocardiograms taken at the eighth and ninth months of pregnancy and shortly after delivery. They did not have the opportunity of studying more complete records. The same was true of Carr and Palmer, who, in their article make a plea for a more comprehensive electrocardiographic study of the normal pregnant woman throughout the entire term of pregnancy.

Just why only four of our cases showed T-wave changes during the course of pregnancy is not understandable. However, our findings are

in accord with those of Feldman and Hill, who report T_3 inversions in only four of their thirty-six cases. We feel that the reason for the electrocardiographic changes noted in all of our cases is definitely the result of monthly examination. It might be postulated that the one case that showed a complete left axis deviation throughout the period of pregnancy and at time of final examination belonged in the group showing

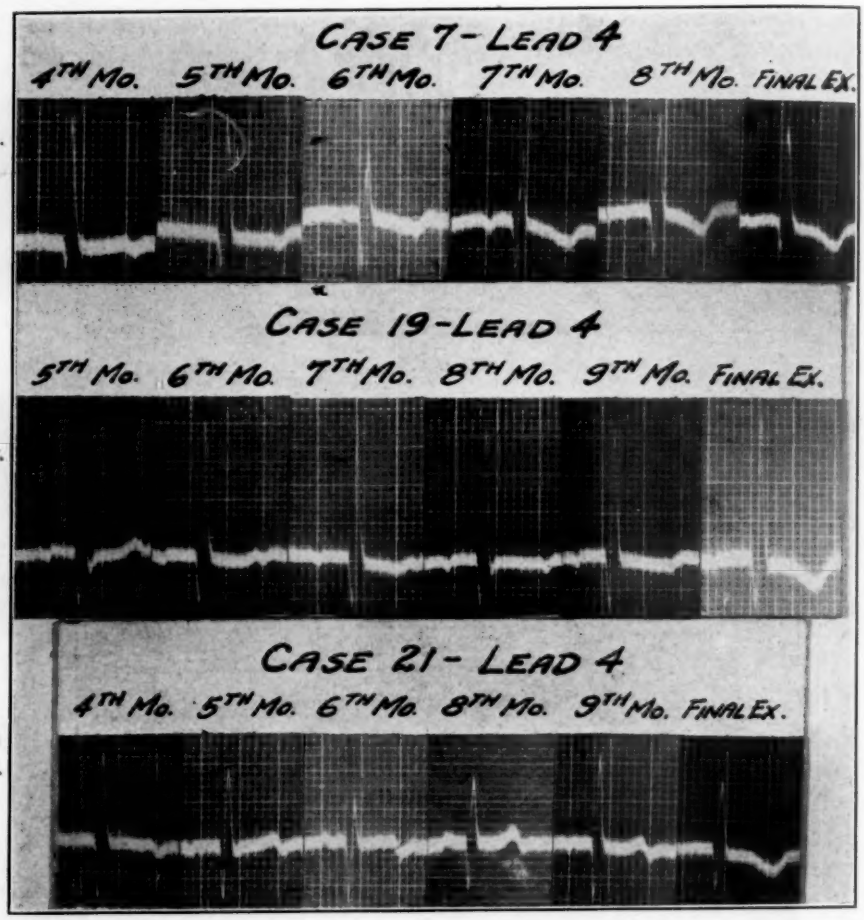

Fig. 10.

T_3 changes because the records did show slight changes in the T-wave in Lead III. It is our belief that the development of a Q-wave of various magnitudes during the course of the pregnancy is nothing more than an expression of a left axis shift, and we concur in this belief with Carr, Hamilton, and Palmer.[6] Surely our records cannot be interpreted on any other basis.

The changes noted in Lead IV (S-T and T-wave changes) have already been commented upon. They are of importance because of their

constancy. There were further changes noted with regard to the relationship of the amplitude of the Q- and R-waves which could not be interpreted because of their inconstancy.

It has been stated by several observers that changes, especially the slurring encountered in the electrocardiogram of the pregnant woman, are the result of toxemia. Jensen and Norgaard felt that the electrocardiographic changes in the pregnant woman were due to the alternating hypertrophy of the ventricles. We can show definitely that these two opinions are erroneous. In the first place these two statements are highly improbable when viewed in the light of clinical and cardiodynamic findings of these nineteen normal pregnant women. In the second place, time after time when the third lead showed maximum changes, a normal third lead could be obtained by making the patient take a maximum inspiration. The following record (Fig. 11) illustrates this and renders untenable an organic explanation for the electrocardiographic changes seen during the course of a normal pregnancy (Case 27, Lead III, at ninth month).

Table II summarizes the nineteen case histories.

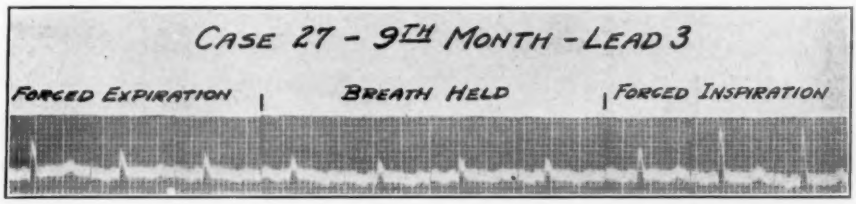

Fig. 11.

SUMMARY

Nineteen normal pregnant women were studied throughout the course of their pregnancy, and the final examinations were made from six to eight weeks after delivery. The study included the correlation of clinical, cardiodynamic and electrocardiographic findings during the period of pregnancy and puerperium. The final examination, approximately two months after delivery, was taken as the control for each case.

The correlation of these findings led us to the following conclusions:

1. Pregnancy definitely places a burden on the cardiocirculatory system.

2. In the normal woman this burden is of the magnitude that can be compensated for by calling on the reserve capacity of this system.

3. The method of compensation for the increased burden is both mechanical and physiological in nature.

4. The electrocardiographic changes observed during the course of pregnancy may be definitely interpreted on the basis of mechanical shifting of the heart.

TABLE II

CASE HISTORIES, IN BRIEF, OF PATIENTS COMPRISING THIS STUDY

(ALSO SEE TABLE I)

CASE NO.	AGE	PREV. PREG.	MISCAR.	FIRST EXAM.	SEROL.*	DELIVERY	ISSUE	SYMPTOMS	POST-NATAL EXAM.
1	23	multip.	0	3rd mo.	Neg.	Nor.	Nor.	diuria and nocturia ++	No abnormalities
2	24	primip.	0	4th mo.	Neg.	Nor.	Nor.	nausea ++, dyspnea +, diuria	No abnormalities
3	30	multip.	0	3rd mo.	Neg.	Nor.	Nor.		No abnormalities
7	19	primip.	0	4th mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
8	20	multip.	0	4th mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
10	30	multip.	0	4th mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
11	28	multip.	0	3rd mo.	Neg.	Nor.	Nor.		No abnormalities
12	19	multip.	0	3rd mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
15	30	multip.	0	4th mo.	Neg.	Nor.	Nor.		No abnormalities
17	26	multip.	0	3rd mo.	Neg.	Nor.	Nor.	dyspnea, polyuria	No abnormalities
18	29	multip.	0	3rd mo.	Neg.	Nor.	Nor.	nausea, vomiting	No abnormalities
19	28	multip.	0	4th mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
20	18	multip.	0	4th mo.	Neg.	Nor.	Nor.		No abnormalities
21	30	multip.	0	4th mo.	Neg.	Nor.	Nor.		No abnormalities
22	28	multip.	0	3rd mo.	Neg.	Nor.	Nor.		No abnormalities
23	28	multip.	0	3rd mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
24	30	multip. (dystocia)	0	3rd mo.	Neg.	Nor.	Nor.	dyspnea ++, fatigue ++	No abnormalities
27	19	multip.	0	4th mo.	Neg.	Nor.	Nor.		No abnormalities
29	30	primip.	0	4th mo.	Neg.	Nor.	Nor.		No abnormalities

*Kahn & Wassermann tests.

5. This shifting of the heart produces a left axis deviation in the electrocardiogram of the majority of the patients studied.

6. The normal woman who does not develop any untoward signs or symptoms during the course of pregnancy shows normal clinical, cardiodynamic, and electrocardiographic findings six to eight weeks after delivery.

Grateful appreciation is acknowledged to the following: John Oldham, for technical assistance, and the American Red Cross, whose aid made this study possible.

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Department of Clinical Reports

IDIOPATHIC HYPERTROPHY OF THE HEART WITH ENDOCARDIAL FIBROSIS*

Report of Two Cases

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IDIOPATHIC hypertrophy of the myocardium has long been the conventional term for classifying cases of enlargement of the heart in infants and young children for which no clinical or pathological basis could be found.

The idiopathic hypertrophies have their chief clinical features in common, but these features are not absolutely distinctive for the group. Although it has been reported in the newborn and in patients as old as four and one-half years, the average age at recognition is fourteen months. Cases of apparently the same condition have been reported in adults,[19] but it is not yet definitely settled whether these represent an idiopathic hypertrophy which was present since infancy or one which arose later in life. It is usual for the mother's prenatal history and the infant's postnatal history to be negative for infections or other conditions of possible etiological significance, although it is frequently noted that the child was "puny" or developed poorly from time of birth. The onset of heart symptoms is usually rapid and may be attended by fever; so that when the child is first seen, the case is frequently diagnosed as an acute infection, usually pneumonia, less often, pericardial effusion. The course tends rapidly to death, which may occur as quickly as an hour or two after the first symptoms are noticed. The three cardinal findings in these patients are cyanosis, dyspnea, and tachycardia. Moderate anemia has been found when the blood was examined and is now considered part of the clinical picture. Edema and heart murmurs are notably infrequent. It must be emphasized that very frequently physical examination of these patients fails to reveal an enlargement of the heart although the enlargement is shown to be considerable both by x-ray and by autopsy examination. Electrocardiography has not been consistent or informative in the few cases in which it has been done.

Many hypotheses have been offered to explain the condition of "idiopathic hypertrophy of the heart" in infants, but none is yet accepted as satisfactory. The probabilities are that the "idiopathic hypertrophies" do not form a single group; that none of the heart cases are truly idio-

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pathic; and that eventually they will be subclassified in different etiological subgroups in spite of the clinical features held in common. A start in the subclassification according to etiology has been made by the recognition of glycogenic infiltration of the muscle fibers as the basis for the enlargement in some cases.[14, 15]

Kugel and Stoloff[2] in 1933 reported a thorough search of the literature by which they collected fifty-two previously reported cases of "idiopathic hypertrophy of the heart" in infants. To this number they added seven of their own, the fourth of which had been previously described in a paper by Stoloff.[1] Since the report by Kugel and Stoloff, sixteen more cases have been reported in the available literature. Four were without benefit of autopsy (Filippi[3]; Dufourt[4]; Debré and Broca,[5] second case; Wilkinson,[6] first case); six did not show any changes in the heart associated with the hypertrophy (Wilkinson,[6] second case; Blechman, Deberdt and Azoulay[7]; Ellis[8]; Debrie, Marie and Bernard[9]; Debré and Broca,[5] first case; Elizalde[10]); of the remaining six, three showed associated endocardial and myocardial changes (Levine,[11] Kenny and Sanes[12]), one showed coaretation of the aorta alone (Root[13]), and two presented extensive infiltration of the muscle fibers by glycogen (Antopol, Heilbrun and Tuchman[14]; Pompe[15]). It is to be noted that Levine's case[11] presented both endocardial fibrosis and coaretation of the aorta. Of the sixty-three autopsied cases of so-called "idiopathic hypertrophy" reported to date, twenty-two have shown, in addition to the cardiac enlargement, endocardial fibrosis and myocardial degenerative-infiltrative changes, the endocardial and myocardial changes occurring either singly or in combination, and being the "simple cardiac defects" most frequently found associated with the hypertrophy.

In view of the relative rarity of the condition it seems well to report two cases of "idiopathic hypertrophy of the heart" which were encountered within a year's time on the routine autopsy service of Vanderbilt University Hospital.

REPORT OF CASES

CASE 1.—The patient, a thirteen-month-old, white female infant, was born normally at full term, free from congenital defects, gained weight, developed normally, and was well until the onset of the present illness seven weeks prior to admission. At that time she contracted a "cold," and several days later had high fever, vomited several times, and seemed quite ill. The local attending physician diagnosed the condition as pneumonia. Her improvement was slow. She continued to breathe fast and to be very restless, but took her feedings well. During the period of improvement she coughed a great deal and vomited occasionally, but no fever was noted. Three days prior to admission there developed generalized edema and some swelling of the abdomen, oliguria, and occasional attacks of cyanosis. On admission the temperature was 101° F., pulse 144, respiration 74, and blood pressure 100/80.

Examination revealed a thirteen-month-old, white female infant acutely ill. There was generalized edema, including the face and hands. The nail beds were cyanotic,

respiration rapid and labored. The neck veins were distended, and the peripheral pulse was feeble. Physical examination and x-ray film of the chest revealed enlargement of the heart to the left, and other signs suggested pericardial effusion. Examination of the lungs revealed nothing remarkable. The liver was enlarged nearly to the umbilicus; the spleen was palpable.

On the strength of the physical findings and the x-ray confirmation, an attempt was made to tap the pericardium. There was obtained 1 c.c. of bloody fluid followed by ⅞ c.c. of light straw-colored fluid. The heart was then felt beating against the point of the needle and the procedure was discontinued. In the late afternoon of the second day, after thirty-six hours of extreme oliguria, she was given 40 c.c. of 30 per cent glucose solution intravenously, and subsequently voided fairly large amounts of urine, and the generalized edema diminished noticeably. Her respiratory distress, however, grew increasingly severe in spite of oxygen tent and stimulants; the temperature rose to 105-106° F.; and on the morning of the third day in the hospital the lungs filled with moisture, and the patient died.

Urinalysis showed albumin, a few hyaline and cellular casts, and many colon bacilli. The red blood cell count was 3,740,000 with 10 gm. of hemoglobin. The total white count was 9,750 with 72 per cent polymorphonuclears. The blood Wassermann test was negative. The blood culture was sterile. The total serum protein was 5.26, with albumin 3.3, and globulin 1.96.

Post-mortem examination was done one hour after death. There were moderate dependent edema, ascites, enlargement of the liver, massive edema of the mesentery and retroperitoneal tissues, and moderate bilateral hydrothorax. The pericardial cavity contained from 50 to 60 c.c. of bloody fluid, and an area of subepicardial hemorrhage was found on the anterior surface near the apex.

The *heart* was greatly enlarged (Fig. 1), extending from a point 2-3 cm. on the right of the midline almost to the left chest wall. It lay in a transverse plane, and all the chambers were dilated. The foramen ovale and the ductus arteriosus were completely obliterated. The aorta was normal, and it was noted that there was no stenosis of the aorta at any point. The great vessels entered and left the heart normally. Both right auricle and ventricle were dilated, and the interventricular septum bulged into the cavity of the right ventricle. The endocardium on the right side was normal in appearance. The left auricle and ventricle were dilated, and the endocardium in each chamber was uniformly thickened and grayish white (Fig. 1). The free margins of the mitral and tricuspid valves showed slight to moderate fibrous thickening, and the major portion of the valves was thickened generally. The chordae tendineae were thickened and shortened, and the papillary muscles were shortened. The septum was intact. The aortic valve was normal.

The lungs and the liver showed evidence of chronic passive congestion. The other organs were not remarkable.

Microscopic Examination.—Heart: The endocardium of the left auricle and ventricle showed marked irregular fibroelastic thickening, the most of the tissue being elastic. The elastic fibers were largest and most compactly arranged in the deeper layers, while toward the surface they became thinner and separated by increasing quantities of finely fibrillar collagenous material. No inflammatory cells were found in the endocardium. Irregular projections of fibrous tissue entered the underlying myocardium and surrounded or replaced large areas of muscle tissue. These areas of fibrosis, too, contained large proportions of elastic tissue. There was marked periarterial fibrosis.

The muscle fibers were not noticeably hypertrophied but showed very marked thinning throughout large areas, especially in the wall of the dilated left ventricle. Some granular changes were present in the muscle fibers, but there was no vacuolation except for an accentuation of the normal vacuolation in the Purkinje fibers. Fat could not be demonstrated, and there was nothing to suggest glycogen infiltra-

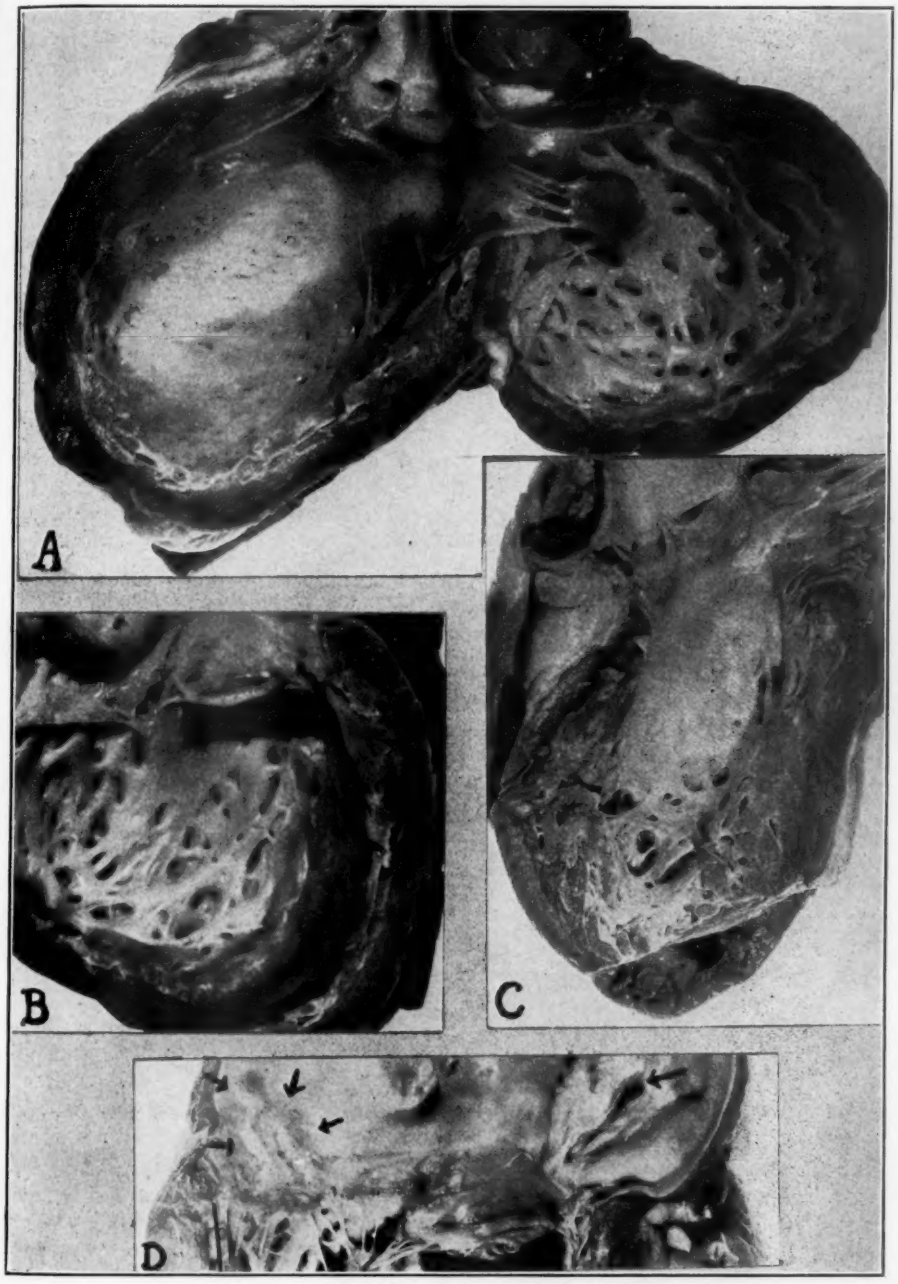

Fig. 1.—*A* (Case 1), left ventricular hypertrophy, dilatation, and endocardial fibrosis. *B* (Case 1), left ventricle and mitral valve. *C* (Case 2), left ventricular hypertrophy and endocardial fibrosis. *D* (Case 2), mitral valve; foramen ovale (arrow) and plaque on wall of left auricle (arrows). The posterior cusp of the mitral valve is seen below the mural plaque.

tion of the fibers. There were many extensive areas of excessive thinning, granular degeneration, and disappearance of the muscle fibers. The interstitial spaces in such areas were filled with fine collagen fibrils and were heavily infiltrated by round cells. Dense collections of large and small round cells were found along the veins but not the arteries. No Aschoff bodies were seen (Fig. 2).

Sections were taken from the right circumflex, left circumflex, left anterior descending, and descending branches of the left circumflex coronary arteries, and studied with hematoxylin eosin, Mallory's aniline blue stain, and Weigert's elastic tissue stain. Their structure conformed closely to the normal for this age group as described by Gross, Epstein, and Kugel.[17]

The lungs and liver presented microscopic evidence of chronic passive congestion, and, in addition, the liver showed massive midzonal hemorrhages and vacuolar and hyaline degeneration of the parenchymatous cells. There was acute splenitis and acute lymphadenitis.

CASE 2.—The patient was a two-and-one-half-year-old white male, who entered the hospital for the first time Feb. 3, 1935, with the chief complaint of asthma. He had always been a "puny" child, and at the age of five months had an attack of pneumonia. The local attending physician at this time said he had a heart murmur which had probably been there since birth. When the child was about eighteen months old, he began to have wheezing attacks. These were characterized by easy inspiration and difficult expiration, and they continued all winter. One such attack was said to have been relieved almost immediately by an injection of adrenalin. With the coming of spring the asthma was almost completely relieved but recurred again in December and persisted to the time of admission. The wheezing now was worse in the middle of the day, less at night or during periods of relaxation, and there was no notable increase in connection with exercise. No cyanosis or dyspnea had been noted. A week before first admission puffiness of the face was noticed, and four days later his face and feet were greatly swollen. There was no past history of rheumatic diatheses. The family history was positive for allergy. His diet had always consisted chiefly of milk.

Examination showed an acutely ill, undernourished, young white boy slightly cyanotic, dyspneic and orthopneic, and generally edematous. There was moderate distention of the neck veins. Physical examination, confirmed by x-ray and fluoroscopy, showed the heart to be markedly enlarged, with pulsations indistinct, but no change in contour with change of position. The rhythm was regular, raté 140, blood pressure 115/82. The sounds were faint, and a soft blowing systolic murmur was heard over the precordium. Electrocardiography showed only sinus tachycardia. The liver was markedly distended; the spleen was not palpable. The child was given extreme measures—oxygen tent, diuretics, stimulants, digitalis—and responded well.

Skin tests showed him to be sensitive to milk, which had been almost his sole article of diet. Blood tests showed a moderate anemia: 3.8 million red cells and 8.5 grams hemoglobin. In accordance with all these findings it was concluded that the condition was entirely due to allergic asthma and nutritional anemia with low serum proteins, all of which had combined to produce cardiac hypertrophy, dilatation, and decompensation. He was accordingly treated by desensitization, proper diet, and whole blood intravenously. There was marked improvement. At time of discharge he wheezed only a little; the heart had decreased in size to within the nipple line; the systolic murmur was still heard, best at the mitral area; and the liver had receded to the costal margin. His enlarged adenoids had been removed during his stay in the hospital.

Three months later he was readmitted. His interval history was that he had done fairly well, though continuing to have some respiratory difficulty. He

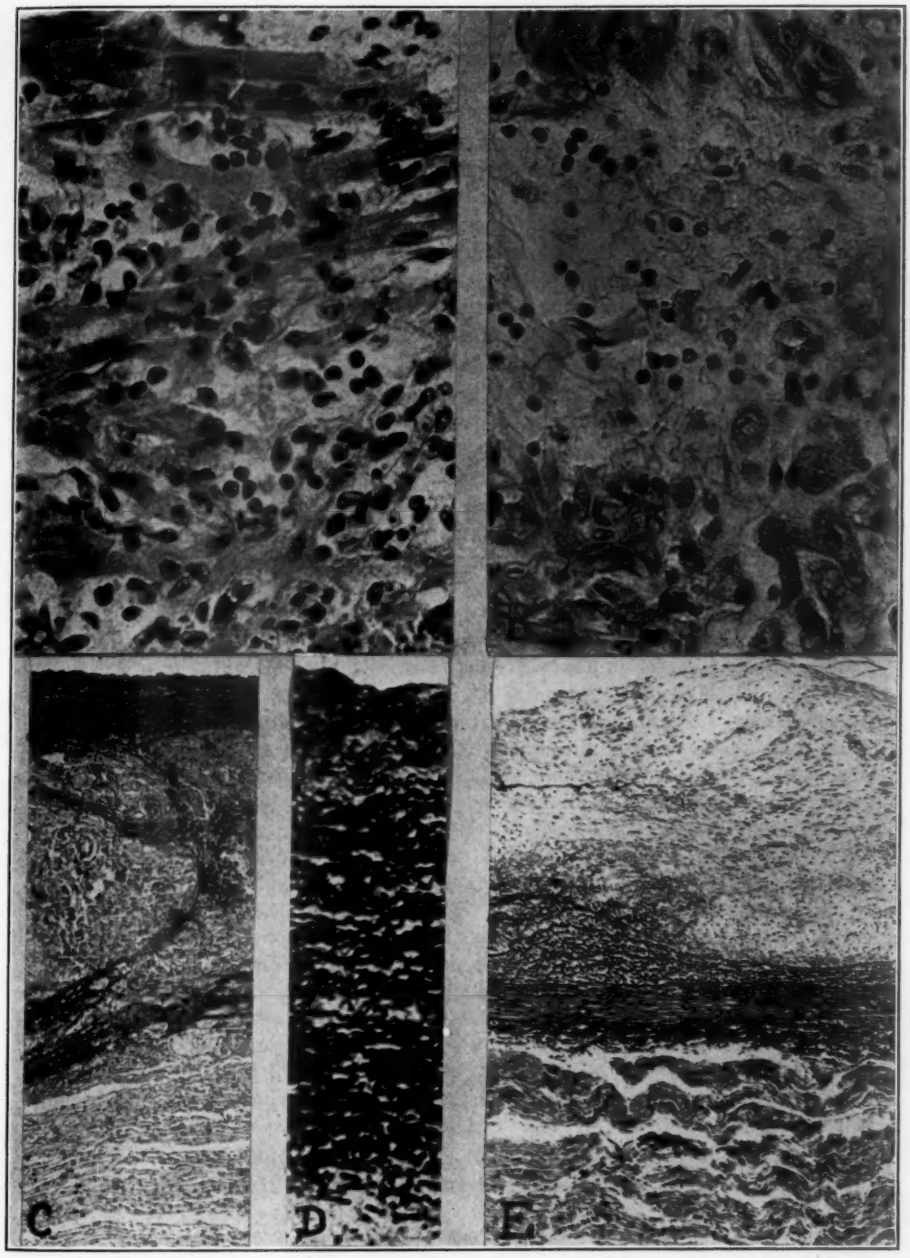

Fig. 2.—*A* (Case 1), myocardial degeneration and infiltration, ×450. *B* (Case 2), myocardial degeneration and infiltration. *C* (Case 1), elastic thickening of left ventricular endocardium. Weigert's elastic stain, ×55. *D* the same, ×280. *E* (Case 2), plaque on wall of left auricle. Weigert's elastic tissue stain, ×55.

returned to the hospital only as a precautionary measure. On this admission the temperature was 98.8° F.; pulse, 120; respiration, 32; and blood pressure, 100/76. The child was not acutely ill. There was no cyanosis, and there was no edema, dependent or otherwise. He breathed with a wheeze and had an occasional cough. Epigastric pulsation was seen. Examination of the heart was the same as on the first admission. The lungs showed some râles, bubbles, and squeaks. The liver was enlarged three fingerbreadths below the costal margin.

The child appeared to be doing well until on the sixth day of hospitalization he suddenly began to have respiratory distress attended with pallor. This increased in spite of all measures including the oxygen tent; acute pulmonary edema developed and became increasingly worse until death supervened some five to six hours after the unexpected onset of acute symptoms.

The blood Wassermann and Kahn tests were negative. The total red blood cell count was 4.2 million; the total white count 9,150 with 55 per cent polymorphonuclears. Total blood serum proteins were 5.82, with albumin 4.3, and globulin 1.52. Routine urinalysis was normal.

Autopsy was performed four and a half hours post-mortem. There was no edema. The serous cavities contained no free fluid.

The *heart* (Fig. 1) weighed 150 gm. Normal weight for a child of this age is 58 gm.[16] Both ventricles were dilated and hypertrophied, the right proportionately more than the left. The wall of the right ventricle was 9 mm. thick, that of the left 1.5 cm. The epicardium was clear and glistening. The entire endocardium showed a diffuse fibrosis most marked in the two left chambers. The myocardium was markedly pale, gray, and flabby. The entire border of the mitral valve was rolled and thickened by confluent, translucent, pink nodules. There was some diffuse fibrosis of the entire valve, but no fibrosis of the chordae tendineae. The border of the posterior cusp of the mitral valve was especially involved, and there was apparently a considerable shortening of the cusp which measured only 3-5 mm. between free and attached borders. Extending up from this cusp onto the wall of the left auricle, covering an area about 1 × 1.5 cm. in size, was a raised irregular patch of the same type of pink translucent tissue found along the border of the mitral valve. The tricuspid valve showed similar nodules along its free border with involvement of a considerable part of one cusp. The main part of the tricuspid valve, however, was thin and translucent; there was little distortion and no diminution in the size of the valve; and there was no fibrosis of the chordae tendineae. These lesions of the mitral and tricuspid valves grossly resembled those of rheumatic fever but were not absolutely typical. The aortic and pulmonic valves were normal. The interauricular septum presented a circular opening 6 mm. in diameter, the rim of which was thick and fibrous and presented many small nodules of the type seen on the mitral and tricuspid valves. Further examination revealed what appeared to be the line of original fusion of the foramen ovale, and it was judged that the opening had resulted from erosion by a process similar to that involving the atrioventricular valves and the wall of the left auricle. The aorta was normal. The large vessels opened into the heart normally. The ductus arteriosus was closed.

The left lung was compressed to almost half the size of the right. The lungs were dense, dark red on section, and very edematous. The gastrointestinal tract was not remarkable. The liver weighed 450 gm., which is normal for a child of this age,[16] and showed no gross evidence of chronic passive congestion. The spleen weighed 80 gm., about twice normal weight, and was very firm. There were no other remarkable features in the gross findings.

Microscopic Examination.—Heart (Fig. 2): The endocardium of all the chambers showed marked fibroelastic hyperplasia, quite irregular in thickness and frequently

extending deep into the myocardium to surround or replace large areas of muscle fibers. This fibrous tissue was composed of elastic and collagenous elements in the same proportions and arrangement as described for the first case. Section of the mitral valve, posterior cusp, and the plaque above it on the wall of the left auricle showed massive and irregular fibrosis of the valve with only a few bundles of fine elastic fibers. There were no inflammatory cells, vessel changes, or other signs of active inflammation in the valve. The plaque on the left auricular wall was composed of two layers—a superficial layer of very edematous fibrous tissue, rich in plump fibroblastic nuclei, lacking any infiltration of inflammatory cells, and showing only a few fine, irregularly disposed elastic fibers. A deeper layer consisted of adult fibrous tissue, chiefly elastic, in compact parallel bundles.

The coronary system was studied as in the first case and likewise was found to be essentially normal.

The perivascular fibrous tissue was much increased. The interstitial tissue as a rule was only slightly increased in amount, but there were many foci in which there was marked interstitial fibrosis of the same composition noted in the endocardium. The muscle fibers did not appear hypertrophic but rather attenuated and distorted. No fat could be demonstrated. There was no vacuolation or other findings suggestive of glycogen in the fibers. There were some areas in which the muscle fibers had disappeared altogether, and there remained only a fine endomysial network within which were many fibroblasts and infiltrating round cells. The capillaries of these areas showed marked swelling and proliferation of the endothelial cells which frequently formed a layer two to four cells thick. A moderate degree of interstitial round cell infiltration was seen in many areas other than those just noted. Occasional interstitial hemorrhage was seen.

The lungs presented microscopic evidence of chronic passive congestion. There was no hypertrophy of the bronchial musculature, eosinophilic infiltrations, or other findings considered indicative of bronchial asthma. A bronchial lymph node contained a well walled-off caseous tubercle. Microscopic examination of the other organs was not remarkable.

DISCUSSION

In both of the cases here reported there was a history of good health from birth to the time of an illness which was diagnosed pneumonia, after which symptoms of heart failure appeared and grew worse to the time of death. It might be interpreted here, as elsewhere,[12] that the sequence was: respiratory infection; toxic myocarditis with degeneration, fibrous repair, dilatation of the surviving muscle fibers; and finally a compensatory hypertrophy. However, the anatomical evidence would indicate that the hypertrophy and the endocardial fibrosis were older than the degenerative-infiltrative process in the myocardium, and, in the first case particularly, seem much older than would be compatible with the relatively short time between "pneumonia" and death. It seems more probable[18] that, granting an acute infection antecedent to the heart failure, the heart was damaged by the infection because it was already in a pathological condition (hypertrophy and endocardial fibrosis) and was susceptible to fatal damage by a minor intoxication that would not have affected a normal heart.

Definite allergy to milk, which had been the main article of diet throughout the patient's life, was a prominent feature of the second

case. The asthma was explained on this basis before death though considerable doubt was raised about the correctness of this explanation when autopsy showed the type of heart that was present. The asthma, in turn, could explain the right-sided hypertrophy and dilatation but could hardly serve as a basis for the left-sided hypertrophy and myocardial-endocardial changes. In view of the resemblance of the lesions on the mitral valve and wall of the left auricle to similarly located lesions in rheumatic fever, the question was raised whether food allergy might not have produced these endocardial lesions by a mechanism analogous to that supposed by some[20, 21] to operate in rheumatic fever. However, there is no clinical or experimental evidence yet to support the idea that food allergy may cause anatomical heart lesions.

Endocardial fibrosis was in these two cases a feature of the heart second in prominence only to the hypertrophy of the myocardium. The associated lesions of the heart valves and, in the second case, of the left auricular endocardium, suggest an inflammatory origin for at least a part of the fibrosis in these cases.

A micrometer was used to compare the size of the individual myocardial fibers in the two cases just reported and in other cases of the same ages free from enlargement or other pathological condition of the heart. This comparison confirmed the original impression that the diameter of the heart fibers was not enlarged and showed that on an average the fibers were thinner than those in the supposedly "normal" hearts. This raised the question of how to explain the marked enlargement of the heart in both cases just reported, and whether it might be explained on the basis of hyperplasia of the fiber bundles rather than of hypertrophy of the individual fibers.

SUMMARY

Two new cases of idiopathic myocardial hypertrophy of infancy are reported. Both cases conformed fairly well to the clinical course which has been recognized as generally occurring in cases of idiopathic hypertrophy, although each had the unusual clinical history of antecedent infection and each presented edema when first seen. Both cases showed fibroelastic thickening of the endocardium, myocardial hypertrophy and dilatation, and microscopic degeneration, round cell infiltration, and fibrosis of the heart muscle. In addition, the second case presented food allergy and asthma, presumably allergic, and on autopsy showed lesions resembling those of rheumatic fever on the mitral value and wall of left auricle.

Antecedent acute infection was considered insufficient to explain the heart changes in these two cases. The history of such infections has been questionable in the majority of cases in which it has been reported; and

it seemed probable that, even when definitely present, the infection was of importance rather for precipitating the acute decompensation than for producing the hypertrophy.

The question was raised whether food allergy may have been responsible for the rheumatoid lesions in the left heart of the second case, and whether the allergic factor is ever present in other cases as an etiologic factor.

No conclusions were reached as to the etiology of the endocardial and myocardial changes in the two cases reported.

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CARDIAC ASTHMA DUE TO OCCLUDING THROMBUS OF THE LEFT AURICLE*

A. Carlton Ernstene, M.D., and Joseph C. Lawrence, M.D.
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CARDIAC asthma usually is due to failure of the left ventricle, which has been damaged previously as the result of hypertension, coronary artery sclerosis, or aortic valve disease. In a small group of cases, however, the same type of paroxysmal dyspnea results from the presence of mitral stenosis without myocardial failure. A series of cases of the latter type has been studied by McGinn and White,[1] who point out that in this group the attacks usually are precipitated by exertion, emotional upsets, or paroxysmal tachycardia. When the heart rate is accelerated by any of these factors, blood is expelled into the pulmonary circulation by the hypertrophied right ventricle more rapidly than it can pass through the narrowed mitral orifice. The resulting acute pulmonary hypertension and congestion causes paroxysmal dyspnea which may be accompanied by asthmatic breathing and may progress to acute pulmonary edema.

In the present communication we wish to report a case of mitral stenosis and subacute bacterial endocarditis in which an occluding thrombus of the left auricle was responsible for a typical attack of cardiac asthma.

REPORT OF CASE

History.—A white male office worker, aged forty-six years, was brought to the hospital by ambulance on March 10, 1936. Approximately four months earlier, he had noted the onset of anorexia and increasing tendency to fatigue, periodic vague distress in the epigastrium and left upper quadrant of the abdomen, and dyspnea and palpitation on exertion. Several weeks after the appearance of these symptoms, an irritating, slightly productive cough had developed. The patient continued to work until February 8, when he was forced to quit because of dyspnea, weakness, and feverishness. At this time the presence of irregular, low grade fever was discovered. During the month before admission to the hospital, there had been frequent attacks of severe retching, and on a few occasions the patient had vomited a small amount of bile-stained material. At times these attacks had been precipitated by a sudden change in position and particularly by sitting up in bed. During the three weeks preceding admission, the patient also had experienced three attacks of severe paroxysmal dyspnea which were not accompanied by wheezing. He had felt compelled to sit up in bed during the seizures but, on doing so in the first two paroxysms, had promptly lost consciousness. None of the attacks had lasted for more than fifteen minutes. There had been a loss of fifteen pounds in weight since the onset of the illness.

Examination.—The patient was well developed and well nourished but appeared to be quite ill. The skin had a light yellowish tint, and the sclerae showed

*From the Cleveland Clinic.

slight but definite icterus. The pupils reacted normally. The jugular veins were not distended. Relative cardiac dullness extended 1 cm. beyond the left midclavicular line in the fifth interspace. The heart rhythm was regular, and the rate was 112 per minute. Over the apex a rumbling murmur was heard beginning early in diastole and extending up to a loud first sound. No other murmurs were present. The pulmonary second sound was louder than the aortic second but was not definitely accentuated. A few medium moist râles were present over the base of both lungs. The liver and spleen could not be felt. There was no clubbing of the fingers, and no petechiae were seen. The arterial blood pressure was 120 mm. systolic and 70 mm. diastolic. The temperature by mouth was 98.4° F.

The red blood cell count was 5,160,000 per cubic millimeter, and the hemoglobin content, 91 per cent. The leucocyte count was 17,600 per cubic millimeter. The urine contained a trace of albumin, many hyaline and finely granular casts,

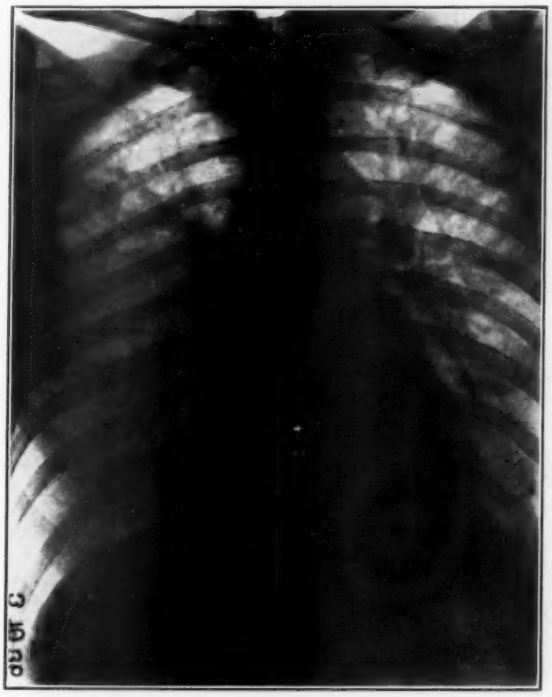

Fig. 1.—Roentgenogram of the chest showing increased hilus shadows with fanlike radiation toward the periphery.

and an occasional red blood cell. The Wassermann and Kahn reactions of the blood were negative. The icteric index was 25. A blood culture gave a growth of nonhemolytic streptococci at the end of sixty hours.

Roentgenograms of the chest (Fig. 1) showed moderate enlargement of the heart, with prominence of the curve due to the pulmonary conus and left auricular appendage. In addition, the lung hilus shadows were greatly increased in width, with extensive fanlike radiation toward the periphery. In the region of the aortic arch, a rather large area of increased density also was present, the nature of which was not clear.

An electrocardiogram showed sinus tachycardia, with a rate of 110 per minute. The maximum amplitude of the QRS complexes was 4 mm. in Lead II. The P-waves were prominent in Leads I and II and the T-waves were isoelectric in all leads.

Clinical Course.—Several hours after admission to the hospital, and while he was lying quietly in bed, the patient suddenly began to experience intense dyspnea. At the same time the lips and nail beds became cyanotic and the face very pale. Profuse perspiration developed, and the hands, forearms, feet, and legs became cold and clammy. The dyspnea increased rapidly in severity so that the accessory muscles of respiration were brought into play, and within a few minutes the breathing became asthmatic in type with loud wheezing, especially during expiration. In spite of the great respiratory difficulty, however, the patient declined to be elevated to a sitting position. Rhonchi were first noted over the upper left anterior chest a few minutes after the onset of the paroxysm. These increased rapidly in numbers and were soon present over all lung fields. Frequent coughing developed early in the attack and was productive of small amounts of thick tenacious sputum flecked with blood. Shortly before the onset of the paroxysm, the pulse rate had been 128 per minute, but the development of dyspnea was attended by a rapid rise

Fig. 2.—Photograph of interior of left auricle showing mitral valve orifice almost completely obstructed by the large vegetative thrombus.

to 140 and then to 154 per minute. The cardiac rhythm remained regular. A decrease in blood pressure to 100 systolic and 70 diastolic was recorded. One-fourth grain of morphine sulphate was administered hypodermically and resulted in gradual, but only partial, relief. One hour after the first appearance of symptoms, moderate dyspnea and wheezing still were present, and sibilant râles were to be heard throughout all lung fields although in diminished numbers. Intermittent cough persisted, and the sputum at this time was bright red in color. The administration of morphine sulphate was repeated, and one hour later the patient was much more comfortable. Numerous rhonchi were still present over the left lung; profuse sweating continued; the nail beds and the lips were deeply cyanotic; and the extremities remained cold and clammy. The pulse rate was 152 per minute; the blood pressure, 85 mm. systolic and 60 mm. diastolic; and the temperature, 103.8° F. The radial pulse wave was barely palpable.

On the following morning, the patient, although comfortable, still appeared to be critically ill. The lips and nail beds remained cyanotic, and the jugular veins were moderately distended. The extremities were cold and clammy. The radial pulse at times could not be felt. The blood pressure was 80 systolic; a diastolic reading could not be obtained. The heart sounds were of good quality, but the diastolic murmur over the apex was less well heard than formerly. The cardiac rate was 96 per minute, and the rhythm was regular. A moderate number of medium râles were present over the bases of both lungs. The liver edge was not palpable. During the latter part of the night, large amounts of greenish fluid had been vomited on four occasions.

Throughout the day the patient's condition remained essentially unchanged except for occasional periods of nausea and a gradual further decrease in blood pressure to 60 systolic. This low level was maintained subsequently with but

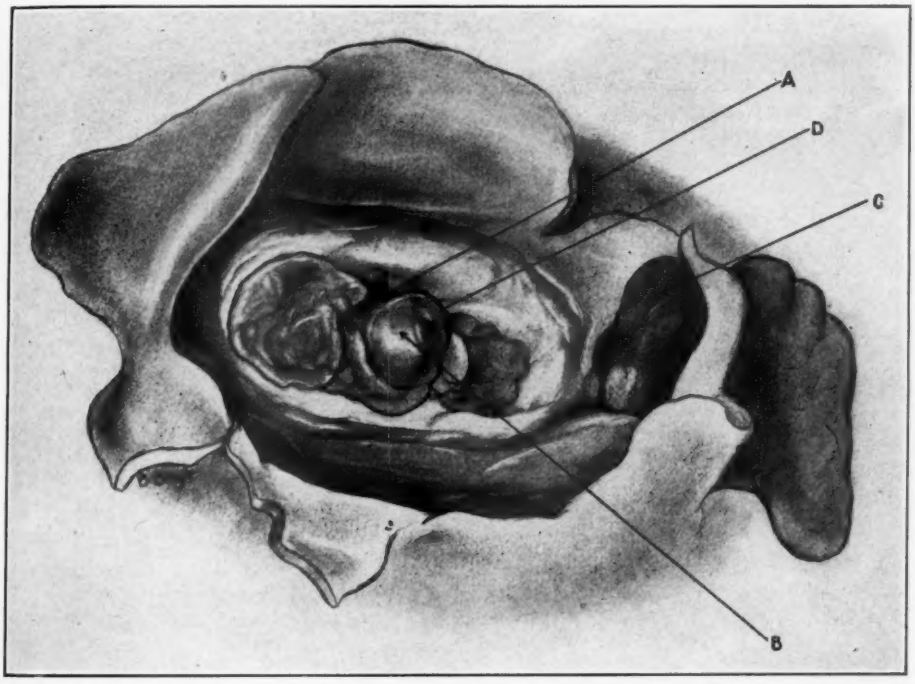

Fig. 3.—Drawing of interior of left auricle. *A*, unobstructed portion of mitral valve orifice. *B*, free portion of vegetative thrombus overlying the mitral valve orifice. The lateral border of the thrombus is indicated by the heavy line. *C*, antemortem thrombus in left auricular appendage. *D*, region of the small area of secondary attachment of the thrombus on its posteroinferior border. The angle of view of the drawing is slightly different from that in the photograph (Fig. 2).

slight variations except for a rise to 76 for a few hours on the morning of the second day after admission. This rise seemed to be accompanied by temporary, slight improvement in the temperature of the legs. The output of urine amounted to 240 c.c. during the first twenty-four hours in the hospital and to but 80 c.c. during the second twenty-four hours. Death occurred on the morning of the third day after admission. The patient remained clear mentally and experienced very little further dyspnea until eight hours before he expired. No petechiae were noted at any time, and no gangrenous areas developed in the extremities.

Post-Mortem Examination.—At necropsy the right pleural cavity contained 1,400 c.c. of clear, straw-colored fluid, and the left pleural cavity, 1,200 c.c. The peri-

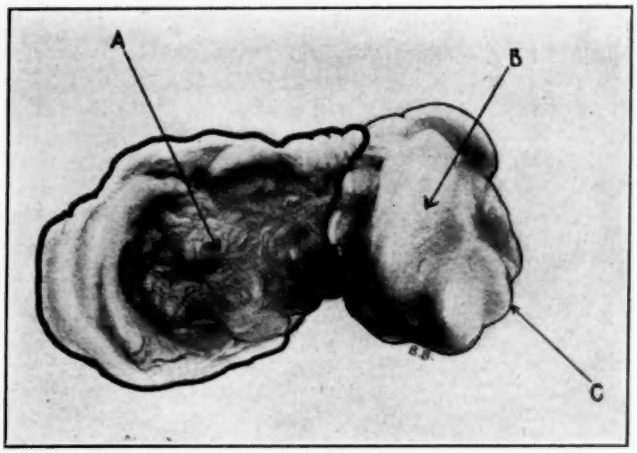

Fig. 4.—Inferior view of the thrombus after its removal. The area of attachment, *A*, has been outlined with a heavy line. The free portion is indicated by *B*, and *C* is directed toward the small area of secondary attachment.

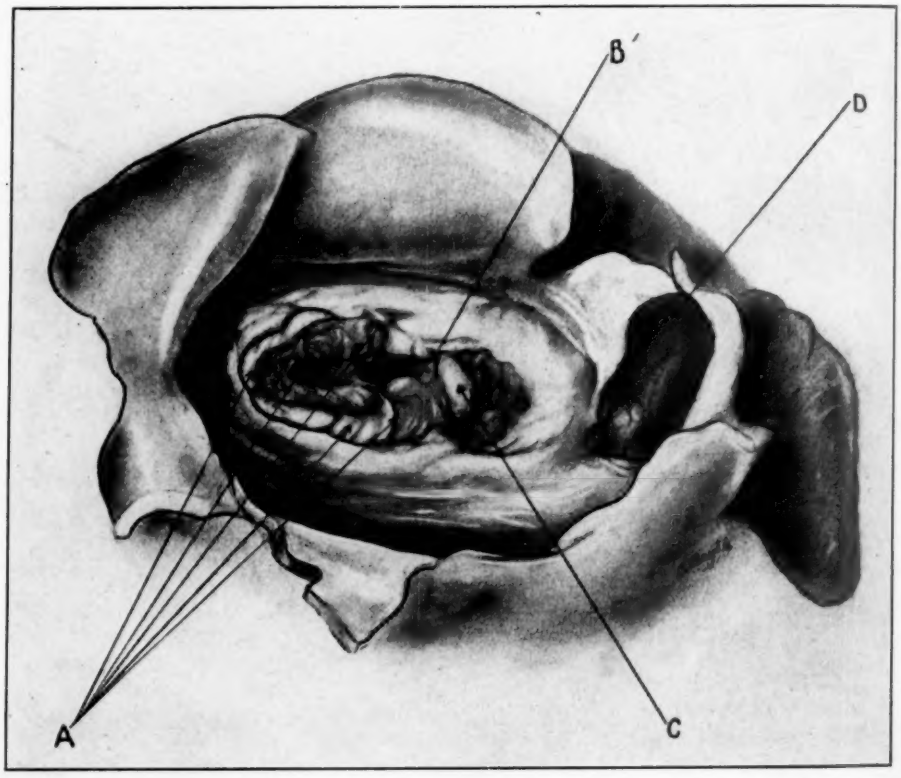

Fig. 5.—Interior of left auricle after removal of the thrombus. *A*, area of attachment of the thrombus. *B*, small area of secondary attachment. *C*, vegetative material not attached to thrombus. *D*, ante-mortem thrombus in left auricular appendage.

cardial sac contained 15 c.c. of clear fluid. A few fresh, fibrinous adhesions were present between the parietal and visceral pericardium over the pulmonary conus. The superior vena cava and the innominate veins were greatly engorged with blood. There were no masses in the mediastinum.

The heart weighed 520 gm. The left auricle, the pulmonary veins, and the right chambers of the heart were greatly dilated and distended with blood. The left ventricle, in contrast, appeared relatively small. The wall of the left ventricle measured 19 mm. at its point of greatest thickness, and the right ventricle 8 mm.

The mitral valve orifice, when viewed from above, was almost completely obstructed by a large, friable, rough, pinkish gray vegetative thrombus which originated from the medial half of the fused leaflets of the valve (Figs. 2 and 3). This thrombus measured 27 mm. in length, 9 mm. in breadth and 3 to 7 mm. in thickness. The medial two-thirds (Fig. 4) was uniformly attached to the underlying structures, but the thicker, lateral one-third was free except for a small area measuring 1 by 3 mm. on the posteroinferior border near the lateral extremity. This latter area was loosely adherent to underlying vegetative material. The free portion of the thrombus completely overlapped the mitral valve orifice except for an area 2 by 3 mm. adjacent to the middle of the posterior leaflet of the valve. In this area there was an indentation in the thrombus, but even here the passage to the left ventricle was not wholly direct since the valve leaflet sloped downward and forward to form a tunnel under the thrombus. A slight degree of free movement was present in the free portion of the thrombus.

After removing the thrombus, a flat, rough vegetative lesion was found completely surrounding the mitral valve orifice except for an area 4 mm. in length on the posterior leaflet (Fig. 5). The valve orifice itself measured 4 mm. by 7 mm. in its greatest diameter. The free margins of the leaflets were firm and greatly thickened. The appendage of the left auricle was filled with an ante-mortem thrombus of recent origin.

The ventricular surface of the mitral valve was free from vegetations. The chordae tendineae were greatly thickened and shortened. The tricuspid, the aortic, and the pulmonary valve leaflets were normal. The tricuspid valve ring measured 11 cm. in circumference, the aortic, 8.3 cm., and the pulmonary, 8.7 cm.

The lungs showed extensive passive congestion. The liver was congested and weighed 1,830 gm. The spleen weighed 490 gm. and contained several old and recent areas of infarction measuring up to 1.5 cm. in diameter. Multiple small infarcts also were found in both kidneys.

DISCUSSION

Occluding thrombi of the left auricle usually are associated with mitral stenosis and auricular fibrillation. Instances have been recorded, however, in which auricular fibrillation has been present without mitral stenosis,[2] and in a few cases,[3] as in ours, the occluding thrombus has resulted from bacterial endocarditis in patients with mitral stenosis and regular rhythm. Regardless of the underlying cause, the most important clinical feature of the condition consists of sudden temporary or permanent changes in the peripheral circulation due to an increase in the degree of occlusion of the mitral valve orifice. These changes consist of diminution or disappearance of the arterial pulsations in the arms and legs, extreme coldness of the extremities, cyanosis, and diminished arterial blood pressure. Circumscribed gangrene may develop in the finger tips, toes, or tip of the nose.

Cardiac asthma has been noted but rarely in the recorded cases of occluding thrombi of the left auricle. Schwartz and Biloon,[4] however, mention the occurrence of paroxysmal dyspnea in two of their three patients, and in one of these wheezing was present and blood tinged sputum was expectorated. In the presence of occluding thrombi, cardiac asthma might be expected to result from either of two mechanisms which would produce acute pulmonary congestion: (1) a rapid rise in heart rate, the factor responsible for the development of cardiac asthma in patients with uncomplicated mitral stenosis,[1] and (2) a sudden increase in the degree of occlusion of the mitral valve orifice due to a change in the position of the thrombus. In our patient, the tachycardia which accompanied the onset of the attack can reasonably be assumed to have been of importance in producing the paroxysm. The diminution in the arterial pulsations in the extremities, the coldness of the forearms, the hands, the legs, and the feet, and the decrease in arterial blood pressure, together with the fact that these changes persisted after the attack had subsided, indicate, however, that an increase in the degree of occlusion of the mitral valve also played an important rôle. No conclusion can be drawn as to which of the two mechanisms was the principal cause of the actual initiation of the seizure.

The three attacks of paroxysmal dyspnea experienced by the patient before admission to the hospital probably were the result of the same changes which produced the paroxysm while he was in the hospital. Whether the syncope which occurred in two of the attacks when the patient sat up was the result of the already greatly impaired peripheral circulation or was due to a further increase in the degree of mitral valve obstruction through the effect of gravity upon the thrombus cannot be stated. The patient's refusal to sit up during the attack in the hospital was in striking contrast to his severe dyspnea.

SUMMARY

Clinical and post-mortem observations are presented on a patient with advanced mitral stenosis, regular heart rhythm, subacute bacterial endocarditis, and an occluding thrombus of the left auricle. The striking clinical feature was the occurrence of an attack of typical cardiac asthma accompanied by tachycardia and signs of greatly impaired peripheral circulation. The latter signs persisted after subsidence of the paroxysmal dyspnea and tachycardia.

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Department of Reviews and Abstracts

Selected Abstracts

Chillingworth, Flex P., Sweet, Marian H., and Healy, James C.: Vascular Injection as Influenced by Negative Pressure. Anat. Rec. **66**: 113, 1936.

When an animal is chloroformed to death, an injection cannula inserted into the left ventricle, and the animal exposed to a negative pressure of 25 to 60 mm. Hg, injection fluid at atmospheric pressure flows in to fill the vascular system more completely than when the animal is at atmospheric pressure and the fluid under high positive pressure. By this new method 60 per cent more fluid can be injected, and minute vessel structure is more clearly outlined.

AUTHOR.

Hopf, E.: A New Electrical Method of Plethysmography in Man. Ztschr. f. Kreislaufforsch. **28**: 318, 1936.

The method which the author used to register arm volume is sensitive enough to pick up changes in volume of 0.03 to 0.04 c.c. It registers the changes in volume during respiration and during the heart cycle.

The method consists of a "beat circuit" in which changes in "beat tone" are produced by alterations in the condenser field caused by volume changes of the arm. The alterations in pitch can be magnified to be heard in a loud-speaker or can be recorded with an oscillograph. These can be rectified with an anode rectifier and then, after amplification, can be recorded with an oscillograph as intensity changes.

L. N. K.

Gilson, A. S., Jr.: The Effects Upon the Heart Rhythm of Premature Stimuli Applied to the Pacemaker and to the Atrium. Am. J. Physiol. **116**: 358, 1936.

Using electrograms recorded from the sinus and from the atrium of the turtle heart, a study has been made of the effect of premature stimuli upon the rhythm of the heart.

If a stimulus is applied to the normal pacemaker in the sinus at such a time as to give rise to an immediate response, the next spontaneous response, as recorded from a point on the sinus close to the pacemaker, occurs at one normal beat interval after this. Subsequent responses follow at normal intervals thereafter.

If a stimulating electrode be placed so as to stimulate either atrium or sinus or both, according to the responsiveness of the tissue concerned at the moment of stimulation, and if lead-off electrodes be placed on the atrium, and if results be considered in terms of the time of the atrial response, it is found that a slightly premature stimulus results in a slight prematurity of atrial response, a slight lengthening of the succeeding cycle because of the compensatory pause, but no displacement of the pacemaker rhythm.

With further prematurity of stimulation, the pacemaker and atrium are stimulated simultaneously. The succeeding interval (as measured from the atrial record) is long but does not show further significant increase as the stimulus is placed earlier.

When the moment of stimulation is brought still earlier in the atrial cycle, the shock finds the atrium refractory but stimulates the pacemaker and causes a corresponding displacement of the rhythm. However, that premature sinus response may be conducted to the atrium, thus causing a premature response of the atrium. Since conduction of this impulse in the relatively refractory phases of sinus and atrium occupies a longer time than normal and since the conduction of the normal sinus beat to the atrium occurs in a normal time, both the cycles preceding and following the premature response will be measured as shorter than a normal cycle.

If stimulating electrodes are placed to touch the atrium but not the sinus, an early premature atrial beat may be elicited without causing a dropping of the next normal atrial beat which appears in its proper time.

AUTHOR.

Robertson, George H.: Heart Disease in General Practice in New Zealand. New Zealand M. J., June, 1936.

This is a survey of 700 consecutive patients suffering with heart disease who were seen in the course of general practice.

Complicating factors have been ignored, and in each case the original etiological factor only has been given so that each patient appears only once.

Criteria accepted for diagnosis have been those recommended by the Heart Committee of the New York Tuberculosis and Health Association.

An analysis of the case notes studied shows arteriosclerosis (32.0 per cent), hypertension (14.3 per cent), cardiac neurosis (21.1 per cent), thyrotoxicosis (11.6 per cent), and rheumatic fever (13.9 per cent) to represent over 90 per cent of the etiological factors.

AUTHOR.

Gladstone, Sidney A.: Oxygen Utilization, Cardiac Output, and Related Circulatory Functions in Graves' Disease. Proc. Soc. Exper. Biol. & Med. **34**: 587, 1936.

In four cases of Graves' disease with an average basal metabolic rate of 33 per cent, the arteriovenous oxygen difference was found to be decreased by 37 per cent. The average cardiac output was 8.1 liters per minute compared with a normal of 4.2, representing an increase of 93 per cent. The relations of the present findings to those previously reported, to the question of method of cardiac output determination, and to the possible nature of the underlying metabolic disturbance in Graves' disease are briefly discussed.

AUTHOR.

Henderson, W. R., and Wilson, W. C.: Intraventricular Injection of Acetylcholine and Eserine in Man. Quart. J. Exper. Physiol. **26**: 83, 1936.

A study is made of the direct injection of acetylcholine and eserine into the ventricles of human beings. The drugs, when injected in this manner, cause typical and similar reactions which are not reproduced by injection of the same amount of the drugs intravenously. The specific action of the drug is prevented or abolished by atropine. The authors conclude from these experiments that the responses of acetylcholine and eserine when injected intraventricularly are the result of action on the cerebral centers and not from peripheral action after absorption into the blood stream. The action of the eserine is thought to be due to inhibition of esterase, thus permitting the accumulation of acetylcholine which is being released at some of the synapses in the brain. Sleep was not produced in these experiments on human beings as was the case in previous work reported by Dikshit performed on cats.

E. A. H.

Altschule, Mark D., and Volk, Marie C.: Therapeutic Effect of Total Ablation of Normal Thyroid on Congestive Failure and Angina Pectoris: XVIII. The Cardiac Output Following Total Thyroidectomy in Patients With and Without Congestive Heart Failure, With a Comparison of Results Obtained With the Acetylene and Ethyl Iodide Methods. Arch. Int. Med. 58: 32, 1936.

Data on the changes in the cardiac output and related aspects of the circulation after total thyroidectomy in twenty-three patients are presented.

The output in volume per minute and the work of the heart are greatly diminished in hypothyroidism following total ablation of the normal thyroid gland.

The cardiac output decreases progressively to a greater extent than the oxygen consumption, as the basal metabolic rate falls in hypothyroidism. This disproportionate decrease in cardiac output is accompanied by a progressive increase in the arteriovenous difference. These changes are most striking when the basal metabolic rate has fallen below -15 to -20 per cent.

In nineteen of twenty-three patients the velocity of blood flow was slowed when the cardiac output was low. In patients with congestive failure the velocity of blood flow was much slower than in those without congestive failure. In three instances the velocity of blood flow did not reflect accurately the work of the heart.

The venous pressure, arterial pressure, and vital capacity were not significantly altered after total thyroidectomy in the patients in this series.

The measurements obtained for the same patients by the acetylene and ethyl iodide methods are compared. The results are the same by the two methods under the conditions of the experiments described.

Reduction in the work of the heart was associated with clinical improvement in the patients studied.

The data obtained in this study are in harmony with the concept that the relief obtained after operation in patients with angina pectoris is due principally to reduction of the work of the heart to, or below, an amount which it can do without the development of anoxemia.

In patients with congestive failure the basal oxygen consumption after total thyroidectomy falls well below the point at which it merely balances the low cardiac output, and the cardiac ouput at rest coincidentally becomes reduced below the preoperative level. This makes it possible for the cardiac output in such patients to increase appreciably in response to work, so that the degree of activity may be increased without discomfort.

In addition, the marked diminution in basal cardiac work which occurs in all patients after operation affords the heart a significant measure of rest.

AUTHOR.

Jackson, D. E., and Jackson, Helen L.: Experimental and Clinical Observations Regarding Angina Pectoris and Some Related Symptoms. J. Lab. & Clin. Med. 21: 993, 1936.

Results of this study show that electrical stimulation inside the esophagus at appropriate locations within the chest produces muscular contractions and pain in exactly those areas of the body in which pain is developed during acute attacks of angina pectoris and coronary thrombosis. The innervation, the authors believe, is ipselateral and does not come from the heart.

The authors believe that the ordinary explanation of angina pectoris being due to coronary artery spasm is erroneous. They believe that angina pectoris is due to acute incoordinated spasmodic contractions of the esophagus (including its longitudinal muscle layers) and stomach whereby gas or other stomach contents are

entrapped under pressure and the walls of either viscus, with their contained or adjacent nerves and tissues, are strained or injured. In this article they present a part of their experimental and clinical evidence to support these views and refer briefly to the relationship to coronary thrombosis.

AUTHOR.

Gross, Kurt: An Electrocardiograph for Quantitative Work for the Practitioner. Ztschr. f. Kreislaufforsch. **28**: 269, 1936.

Description is given of a new portable electrocardiograph which does not distort the deflection, with a criticism of some other German models which do cause distortion.

L. N. K.

Wagenfeld, E.: Auricular Flutter Converted to Nodal Rhythm by Digitalis. Ztschr. f. Kreislaufforsch. **28**: 433, 1936.

An unusual case is presented in which auricular flutter is converted during digitalization into auricular fibrillation and later into nodal rhythm with bigeminal beats. At times sinus arrhythmia occurred in this patient accompanied by S-A block.

L. N. K.

Katz, L. N., Gutman, I., and Ocko, F. H.: Alterations in the Electrical Field Produced by Changes in the Contacts of the Heart With the Body. Am. J. Physiol. **116**: 302, 1936.

Experiments are reported in which various regions of the heart were connected to various parts of the chest by a good electrical nonpolarizable shunt. The alterations obtained were of two sorts (or intermediate or mixed forms): (a) diphasic additions when the region under the shunt electrode was not injured and (b) monophasic additions when the region under the shunt electrode was injured.

It is demonstrated that regions of the heart may gain a decided advantage over the rest of the heart merely because they are in contact with a good electrical conductor, provided that the contact is electrically nearer to one than the other of the two recording electrodes.

It is demonstrated that the point on the chest to which the heart currents are shunted determines the advantage of the heart region so shunted over the rest of the heart. This depends on the "electrical distances" between the recording electrodes and the point of shunt on the chest.

It is demonstrated that the electrical resistance of the shunting circuit determines the degree of advantage gained by the heart region shunted; the less the electrical resistance of the shunt, the greater the advantage.

It is suggested that the shunted region of the heart sets up its own electrical field in the body which summates with that set up by the heart through its natural contacts.

These experiments support the concept that the nature of the electrical conductors in contact with the heart are an important, if not the most important, element in determining the nature of the electrical field set up by the heart and thereby in determining the contour of the electrocardiogram obtained with recording electrodes at a distance from the heart. They also support the concept that alterations in the relation of various regions of the heart to the good electrical conductors and alterations in the location of the latter are important factors in modifying the ordinary electrocardiogram.

AUTHOR.

Katz, L. N., Sigman, E., Gutman, I., and Ocko, F. H.: The Effect of Good Electrical Conductors Introduced Near the Heart on the Electrocardiogram. Am. J. Physiol. **116**: 343, 1936.

The introduction of good electrical conductors adjacent to the heart causes alterations in the electrical records obtained from direct, from distant, or a combination of direct and distant electrodes.

Evidence is given to suggest that the conductors introduced operate by (a) offering a by-pass for the currents generated by the heart, thereby decreasing the amount of current passing through the galvanometer circuit; (b) altering the path taken by the currents from the heart to distant points; (c) altering the relative contribution of the various regions of the heart to the recorded electrical curves; and (d) creating electrical stresses, the result of frictional electricity between dissimilar conductors.

The relative importance of these actions depends on (a) the manner of recording the electrical curves, (b) the presence or absence of regions of injury in the heart, and (c) the nature and location of the electrical conductor introduced.

These observations reemphasize and define, in part at least, the importance of the electrical properties of tissues adjacent to the heart in determining the electrical field set up by it.

AUTHOR.

Faxen, Nils: Paroxysmal Tachycardia and Bundle-Branch Block in a Boy of 11. Acta pediat. **18**: 491. 1936.

The case described illustrates the value of electrocardiographic examination and at the same time shows an unusual complication with paroxysmal tachycardia in childhood. There was a history of rheumatism which probably accounted for the bundle-branch block. The etiology of the tachycardia is not explained. It is suggested that it may be a congenital defect.

H. McC.

Schwartz, Sidney P.: Studies on Transient Ventricular Fibrillation. III. The Prefibrillatory Mechanism During Established Auriculo-Ventricular Dissociation. Am. J. M. Sc. **192**: 153, 1936.

The clinical and electrocardiographic manifestations in six patients with A-V dissociation who exhibited recurrent syncopal attacks due to transient ventricular fibrillation have been correlated.

In each instance it was determined that the alterations in the rhythm of the heart preceding a period of ventricular fibrillation were characterized by an acceleration of the basic ventricular rate of the ventricles.

The acceleration of the ventricular rate preceding ventricular fibrillation in patients with A-V dissociation was effected through: (a) a simple and progressive shortening of the interventricular periods; (b) a steplike progression of both auricles and ventricles with abrupt changes from partial to complete heart-block and vice versa, each alteration resulting in a further acceleration of the ventricular rate; (c) the interposition of a single extrasystole changing a slower rhythm to a faster one with a concomitant change in the pacemaker of the ventricles; (d) recurrent short runs of tachycardia arising in an ectopic focus of the ventricles and alternating with the periods of heart-block; (e) a tachysystole in which a rapid auricular rate kept pace with a rapid ventricular rate before fibrillation disrupted the whole cardiac mechanism; and finally (f) isolated premature beats of the ventricles which appeared in rapid succession and accelerated the heart before the cardiac mechanism responsible for syncope had set in.

On the basis of these correlated observations, it is fair to assume that a diagnosis of transient ventricular fibrillation may be suspected in a patient with A-V dissociation and syncopal attacks if any of these cardiac mechanisms are observed to appear either prior to or subsequent to syncopal seizures.

AUTHOR.

Webster, Bruce, and Cooke, Crispin: Morphologic Changes in the Heart in Experimental Myxedema. Arch. Int. Med. **58**: 269, 1936.

Myxedema was readily produced in adult rabbits by total removal of the thyroid gland. In the cases of more severe involvement this was accompanied by pericardial and peritoneal effusions. The heart muscle of these myxedematous animals had an average fluid content of 81.9 per cent, as compared with 75.6 per cent in a control series of normal animals. On microscopic examination this heart muscle showed marked degenerative changes, characterized by a decrease in the number of fibers, edema, and a disappearance of the perinuclear sarcoplasm.

Myxedema is apparently capable of producing serious myocardial damage in the adult rabbit.

AUTHOR.

Hochrein, M., and Schneyer, K.: Prognosis of Myocardial Infarction. Ztschr. f. Kreislaufforsch. **28**: 257, 1936.

Myocardial infarction is a serious concern of the cardiologist because of its high mortality and the restriction of activity in those who survive. The authors found a mortality rate of 71 per cent in their group of 226 cases. In 97 cases death occurred within a few days. During convalescence, 24 died of heart failure, 16 from the infarction, 7 from emboli, and 7 from secondary heart causes. There were 65 who survived, but only 23 without incapacity, while 22 had dyspnea on effort, 17 had stenocardia, and 14 had edema.

Of bad prognostic omen are (a) atypical clinical and electrocardiographic findings, (b) signs of secretory insufficiency, and (c) appearance of cardiac insufficiency. Normal vital capacity and a rapid return of blood pressure are favorable signs. Recovery is retarded by irregular habits, sexual excesses, and emotional upsets.

L. N. K.

Shookhoff, Charles, Douglas, Albert H., and Rabinowitz, Meyer: Sedimentation Time in Acute Cardiac Infarction. Ann. Int. Med. **9**: 1101, 1936.

The red blood cell sedimentation time was studied in twenty-nine cases of acute cardiac infarction. It was abnormally rapid in all.

It became rapid between the second and fifth days and returned to normal between the thirteenth and thirty-ninth days.

An abnormal sedimentation rate may outlast the return of temperature and leucocyte count to normal by as much as four weeks. It may be abnormal when the temperature and leucocyte count have been normal throughout.

It is of great help in cases seen first several days or weeks after the occurrence of a cardiac infarction. It helps in the recognition of subsequent thrombosis or infection. It makes less arbitrary the duration of bed rest.

AUTHOR.

Mullins, William L.: Age Incidence and Mortality in Coronary Occlusion. Pennsylvania M. J. **39**: 322, 1936.

The age incidence and mortality of 400 cases examined from the Heart Department of the Mercy Hospital, Pittsburgh, are tabulated. The immediate mortality in all cases was 9 per cent. In 80 cases seen between July, 1928, and July, 1930,

the immediate mortality was 7.2 per cent. Fifty-two of these patients are living at the present time. There was no immediate mortality in patients whose attacks occurred before age forty years. The immediate mortality increased gradually from ages forty to eighty years. Initial attacks occurred almost twice as frequently during the winter as during the summer months.

H. McC.

Schwarz, Hans G.: Concerning the Power of the Heart in Severe Congenital Involvement. Ztschr. f. Kreislaufforsch. **28**: 385, 1936.

A case report is presented of an eleven-year-old child with severe congenital heart disease. Auricular fibrillation developed following pneumonia, but this lung infection led to no other evidence of damage to the heart.

L. N. K.

Summerfeldt, Pearl: Some Problems in Heart Disease in Childhood. Canad. M. A. J. **35**: 165, 1936.

The author reviews the experiences of cardiac children at the Hospital for Sick Children in Toronto. The findings in this study are similar to those made in studies elsewhere. Emphasis is placed on the importance of respiratory and tonsil infection in relation to the etiology of rheumatic fever and heart disease.

H. McC.

Friedmann, R.: The Influence of Cardiac Valvular Disease Upon the Duration of Life. Ztschr. f. klin. Med. **130**: 382, 1936.

The study is a numerical survey of the death rates of 1,164 patients with rheumatic valvular disease seen in the heart station in Vienna between June, 1919, and January, 1935. Analysis is made according to age, various types of valvular lesion, and size of heart. Comparison with the general death rate for Austria is given, and several interesting facts are set forth: most important among which are that (1) for all types of valvular disease together the death rate is slightly more than two and one-half times the general death rate, (2) combined mitral and aortic disease has the highest mortality rate (3¼ times the general death rate), and (3) aortic disease has the lowest mortality rate (less than twice the general death rate). The highest death rate for all types of valvular disease together occurred in the fifth decade (4¾ times the general death rate).

Many other more detailed comparisons are made. Two others deserve mention. The author cannot confirm the statements that the highest death rate is in the second and third decades following the rheumatic groups of infections; from his figures he decides that death rate depends rather upon the age of the patient. He also found that the duration of life becomes rapidly less with increase in size of the heart.

J. M. S.

Parhon, C. I., and Ornstein, J.: Preventive Treatment of Arteriosclerosis and Atheromatosis. Schweiz. med. Wchnschr. **65**: 1164, 1935.

Arterial hypertension and hypercholesterolemia are two incontestable factors in the development of arteriosclerosis and atheromatosis. There is sufficient clinical and experimental basis for considering that certain endocrine dysfunctions are definitely associated with alterations in the blood cholesterol, namely, diseases of the ovaries, suprarenals, and thyroid gland. In exophthalmic goiter the mean level of the blood cholesterol is 161 mg. for each 100 c.c. of blood, in simple goiter it

is 200 mg., and in myxedema it is 190 mg. Other published articles show that in experimental and surgical thyroid deficiency there is an elevation of the blood cholesterol. It seems rational to consider that the treatment of hypercholesterolemia by the use of thyroid extract can be considered as preventive for the development of arteriosclerosis and atheromatosis. Five cases are reported in which the cholesterol of the blood was reduced by from 20 to 55 mg. after treatment with thyroxin orally, hypodermically, or intravenously. There was also a diminution in the total lipoids and fatty acids paralleling the decrease in the blood cholesterol and reduction in the water content of the tissue following the administration of thyroid.

N. W. B.

Eberhard, T. P.: Effect of Alcohol on Cholesterol-Induced Atherosclerosis in Rabbits. Arch. Path. 21: 616, 1936.

Through observation of the effect of alcohol per se on the rabbit fed cholesterol, the author hoped to shed some light on the widely held impression that drunkards do not show so much arteriosclerosis for given age groups as do temperate persons.

The cholesterol of the blood rose more rapidly and to higher levels in those animals which ingested both substances than in those which received cholesterol alone. The deposition of cholesterol in the tissues of liver and aorta, however, occurred in inverse ratio to the blood figures.

L. H. H.

Haythorn, S. R., Taylor, F. A., Crago, H. W., and Burrier, A. Z.: Comparative Chemical and Histological Examinations of Aortas for Calcium Content. Am. J. Path. 12: 283, 1936.

As a result of careful chemical determinations of metallic calcium and microchemical studies for visible calcium on fifty-two aortas from patients of varying ages, the authors found a consistent increase of calcium in aortas of patients beyond middle age in excess of that of other body tissues.

Von Kossa's silver method was found the most satisfactory microscopic indicator of the comparative amounts of calcium in sclerotic lesions.

The heaviest calcium deposits were in the abdominal portion. Positive microscopic tests began at the age of forty years and were 100 per cent positive in the specimens from patients between sixty-one and seventy years of age.

Mild intimal lesions may occur without any increase in calcium by chemical analysis.

L. H. H.

Hallock, Phillip: Arteriosclerosis in Young Diabetics. A Method for Its Recognition by Arterial Elasticity Measurements. Am. J. M. Sc. 192: 371, 1936.

The pulse-wave velocity method was utilized in studying arterial elasticity in the large and medium sized arteries of twenty-two young diabetics. To test the significance of the pulse-wave velocities obtained in this study the well-known Chi-square test was employed. While the values for the transmission of the aortic pulse wave did not indicate any significant changes from the normal, those for the transmission of the radial pulse wave were definitely significant.

The diabetic state either initiates early, or accelerates the development of premature, arteriosclerosis in the young adult.

AUTHOR.

Duff, G. Lyman: The Nature of Experimental Cholesterol Arteriosclerosis in the Rabbit. Arch. Path. 22: 161, 1936.

When arteriosclerosis was produced in rabbits after the method of Anitschkow, the first appearance of deposits of anisotropic lipoids occurred in spontaneous medial lesions of the aorta. Such spontaneous lesions remained free from such deposits in the control animals, to which no cholesterol fed rabbit deposits lipoid first at the site of an arterial injury.

Photomicrographs and descriptions of the arteries are presented.

AUTHOR.

Pickering, G. W.: The Peripheral Resistance in Persistent Arterial Hypertension. Clin. Science. 2: 209, 1936.

Under similar environmental conditions the rate of blood flow through the forearm is the same in subjects with essential hypertension, malignant hypertension, and chronic nephritis with hypertension as in subjects with normal blood pressures. The resistance offered by the vessels of the forearm is increased in these conditions owing to vasoconstriction, the blood viscosity being normal or less than normal. The increased vascular resistance is of such an order that, if generally distributed throughout the body, it would account for the levels of arterial pressure observed. After periods of circulatory arrest lasting up to ten minutes, the rate of blood flow through the forearm increases to the same extent in subjects with persistent hypertension as in normal subjects. It is concluded that in chronic nephritis and essential hypertension the abnormal agent narrowing the vessels is not nervous.

E. A.

Hutton, J. H.: Hypertension and Diabetes: Their Treatment by Radiotherapy. Am. J. Roentgenol. 55: 813, 1936.

For some years, the author has believed that essential hypertension and diabetes mellitus are due to some dysfunction, probably overactivity, of the pituitary or adrenal glands. He discusses the rationale of this contention and indications for treatment with radiotherapy. For two and a half years, a group of such patients has been treated, using varying dosages and numbers of treatments. Both sides of the pituitary and adrenals were treated at the same time. In many of the patients, there was a marked fall in blood pressure and almost complete symptomatic relief after the first treatment. In others the favorable results were slow, and in a few there was little or no effect from the treatment. There is frequently no correlation between the relief of the patient's symptoms and the reduction in the blood pressure. In certain of the patients there were interesting and favorable by-effects, such as correction of menstrual irregularities and relief of vasomotor phenomena in women who were treated during the menopausal state. Whether these effects are permanent, is not as yet determined.

E. A. H.

Bradshaw, H. H.: Fall in Blood Pressure During Spinal Anesthesia. Ann. Surg. **104:** 41, 1936.

Experiments performed with the use of a colored solution of 10 per cent procaine crystals on five healthy and four completely sympathectomized cats indicate that the fall in blood pressure resulting from the subdural injection of procaine is due to paralysis of the vasoconstrictor nerve fibers. In the unsympathectomized animals, there was a marked fall in blood pressure following the subdural procaine injection but very little fall in the blood pressure of the sympathectomized

animals. From observations of the fall in blood pressure at different levels, it would appear that the vasoconstrictor fibers from the fifth thoracic level down are the most important factors in the type of blood pressure reaction occurring under spinal anesthesia. Measures indicated to prevent this blood pressure fall in humans are discussed.

E. A. H.

Motley, Lyle: Periarteritis. J. A. M. A. **106**: 898, 1936.

The important features of this case are generalized involvement of somewhat migratory character, marked eosinophilia of peripheral blood, diagnosis during life and apparent recovery.

AUTHOR.

Dunphy, J. E.: Abdominal Pain of Vascular Origin. Am. J. M. Sc. **192**: 109, 1936.

Evidence is presented to show that vascular disease of the mesentery can cause abdominal pain in the absence of gangrene or peritoneal irritation. It is suggested that pain so caused is the result of an anoxemia of the intestinal musculature and is a true visceral pain conducted by sensory neurones in the sympathetic nerves independently of the musculocutaneous pathways. The importance of recognizing the characteristics of this type of pain in the early diagnosis of mesenteric vascular occlusion (arterial) is emphasized.

AUTHOR.

Collins, Dean A.: Hypertension From Constriction of the Arteries of Denervated Kidneys. Am. J. Physiol. **116**: 616, 1936.

Experiments in which the arterial blood pressure of male dogs is followed after constriction of both renal arteries and denervation of both kidneys indicate that the arterial hypertension thus produced is independent of the nervous connections of the kidney. The technic employed in constriction of the renal arteries is after the method of Dr. F. C. Mann. Completeness of the denervation is checked by histological examination for the presence of nerves in the structure of the renal pedicle. Renal function as tested by the nonprotein nitrogen and phenolsulphonephthalein renal function test is not significantly altered by bilateral renal artery constriction, nor are there any histological changes observable in the kidney.

E. A. H.

Cohen, Sidney Slater, and Barron, Maurice E.: Thrombo-Angiitis Obliterans With Special Reference to Its Abdominal Manifestations. New England J. Med. **214**: 1275, 1936.

To the thirty-five published reports of autopsies on patients with thromboangiitis obliterans, the authors add four of their own. Necropsy evidence of thromboangiitis obliterans involving the vessels other than those of the extremities was found in several instances, which are grouped as follows: abdominal, 4 cases; coronary, 2 cases; hypogastric, 1 case; pulmonary, 1 case; intracranial, 1 case. Additional summary is given of eleven published cases of presumptive thromboangiitis obliterans of abdominal vessels; necropsies were not performed. One such case is added by the authors. It is important to keep in mind the possibility of involvement of the abdominal vessels when acute abdominal crises occur in patients with thromboangiitis obliterans.

H. M.

Marx, H.: Diseases of the Arterial System; Newer Experimental Results. Deutsche med. Wchnschr. **1**: 502, 1935.

It is possible through stimulation of the hypophysial system to produce disturbances in renal function and an increase in blood pressure. In the blood, and particularly in the urine, of individuals with kidney disease, substances can be demonstrated which produce hematuria and hypertension and inhibition of diuresis similar to that produced by the posterior lobe hormone. Disturbance in the central regulation is not the only factor in the pathogenesis of kidney and blood vessel disease but other factors, such as infection, central nervous disturbances, and hormones, are important. There is a coordination of the various factors. All of them must be sought for and determined. The treatment of patients then is dependent upon all of these.

E. A.

Dittrich, R. J.: Peripheral Vascular Disease With Gangrene of Extremities. Am. J. Surg. **32**: 533, 1936.

A vasospasm in a child of four years leading to serious trophic changes in hands and feet was relieved by surgical removal of masses of fat and fibrous tissue encroaching on the cervical and lumbosacral cord.

L. H. H.

Pyro, Reinhold: Significance of Various Types of Massive Limb Injury in Producing Gangrene. Ztschr. f. Kreislaufforsch. **28**: 305, 1936.

The case reports include instances of frost-bite followed after an interval by gangrene caused by endarteritis obliterans and thrombosis, one case of Raynaud's disease with gangrene, one of erythromelalgia and one of cutis marmorata. A polemical discussion of the mechanisms involved is presented.

L. N. K.

Murray, D. W. Gordon: Embolism in Peripheral Arteries. Canad. M. A. J. **35**: 61, 1936.

The author reviews the records of the Toronto General Hospital for the past five years, showing 126 cases of arterial embolism. He analyzes the series statistically and describes the important symptoms for diagnosis of such cases. Of these, he discusses fully pain, the color, temperature, sensory changes, paralysis, and pulsations in the affected part. He believes the diagnosis can usually be made without difficulty by careful observation of the clinical signs and symptoms.

In early cases embolectomy offers good results while neglected cases usually terminate with amputation or death.

H. McC.

Lummis, F. R.: Periarteritis Nodosa. Ann. Int. Med. **10**: 105, 1936.

A case of periarteritis nodosa diagnosed during life and confirmed by biopsy is reported. The striking features were a long period of ill health with persistent fever, peripheral neuritis, muscular atrophy, renal impairment, gastrointestinal symptoms, and marasmus. Arsenic therapy reduced the temperature to normal but did not relieve the symptoms or arrest the progress of the disease.

E. A. H.

Lewis, T.: Pain as an Early Symptom of Arterial Embolism and Its Causation. Clin. Sc. **2**: 237, 1936.

The early and often severe pain of embolism, or arterial thrombosis, is considered to be the result of ischemia of muscles in the limb. This conclusion has been based upon the facts that the pain is usually felt in the limb distal to the obstruction and because in nonmuscular organs, as the brain, lungs, and spleen, embolism or thrombosis is usually painless. The author obtained this information from a review of the literature and by direct observation on a number of his patients.

E. A. H.

Edwards, H. T.: Lactic Acid in Rest and Work at High Altitude. Am. J. Physiol. **116**: 367, 1936.

Resting lactic acid values determined on blood drawn in the morning before rising show an initial slight rise over sea level values on going to high altitudes. Sea level values are found after acclimatization even at 6.14 km., where arterial saturations range between 55 and 70 per cent.

Standard work performances, on first going to high altitudes, produce greater rises in blood lactic acid than at sea level. After acclimatization lactic acid values similar to those at sea level are found for a given performance. The ability to perform work is lessened progressively with increase in altitude, hence also the ability to accumulate lactic acid. Only slight increases over rest values of lactic acid are found during work at 6.14 km.

The inability to accumulate large amounts of lactic acid at high altitudes suggests a protective mechanism preventing an already low arterial saturation from becoming markedly lower by shift of the oxygen dissociation curve through acid effect. It may be that the protective mechanism lies in an inadequate oxygen supply to essential muscles, e.g., the diaphragm or the heart.

AUTHOR.

Wilson, H. C.: The Relation Between Rhythmic Variations in Blood Pressure and Rhythmic Contractions of the Artery of the Ear of Rabbits and Dogs. Am. J. Physiol. **116**: 295, 1936.

The spontaneous rhythmic contractions in the main artery in the rabbit's ear have been studied in the preformed transparent chamber by Clark and Clark, and Wilson and others. In a new series of experiments simultaneous records of the blood pressure and observation of contractions of the main artery of the ear in rabbits and dogs have been made. In all of the experiments in this study whenever there were definite waves in the blood pressure, there were synchronous rhythmic contractions in the main artery of the animal's ear. It is impossible that the changes in the ear artery alone could account for the magnitude of the changes in the general blood pressure. Probably rhythmic changes in the blood vessels in various parts of the body are the cause of the blood pressure waves previously described. This would rule out a local origin for this phenomenon but not the possibility of some chemical agent being responsible for these rhythmic changes. The inhibitory effect of anesthetics and the stimulating effect of morphine on these rhythmic contractions are described.

E. A. H.

Mahorner, H. A., and Ochsner, A.: A New Test for Evaluating Circulation in the Venous System of the Lower Extremity Affected by Varicosities. Arch. Surg. **33**: 479, 1936.

The current tests used for evaluation of circulation in varicose veins are discussed. A new test is described for determining the direction of flow of blood in

the venous system in the lower extremities affected by varicosities and for determining the competency of the valves of the long saphenous vein and the connecting veins between the superficial and deep systems of the thigh. The test is of value in determining the most suitable type of therapy and the possibilities of recurrence after treatment.

E. A. H.

Saylor, Leslie L., and Wright, Irving S.: Studies on Two Cases of Urticaria From Cold Sensitivity and of the Effect of Histamine Treatment. Am. J. M. Sc. **192**: 388, 1936.

Two cases of urticaria, both in females, from cold sensitivity are reported.

In the first case rather extensive experimental studies were possible. The beneficial effects of histamine treatment were observed.

That the reaction occurred at an unusually high skin temperature in this case was demonstrated.

Experiment points toward the humoral hypothesis of cause of reaction.

The second case is reported primarily because of the complete collapse when the patient was swimming in cold water.

AUTHOR.

Robertson, Harold F., and Fetter, Ferdinand: The Effect of Venesection on Arterial, Spinal Fluid, and Venous Pressures With Especial Reference to Failure of the Left and Right Heart. J. Clin. Investigation **14**: 305, 1935.

A series of experiments was carried out to determine the relation of arterial, spinal fluid, and venous pressures before and after venesection.

It was found in right heart failure that venous and spinal fluid pressures were elevated and related with respect to fall of pressures induced by venesection. The variation in the ratio between the two pressures is shown by the divergences from a linear distribution.

The spinal fluid pressure was elevated above normal in 32 per cent and 85 per cent of left and right heart failures, respectively. No correlation obtained between the arterial blood pressure and the venous or spinal fluid pressures in either right or left cardiac incompetence. The venous and spinal fluid pressures were uncorrelated in failure of the left heart. The spinal pressure was greater than the venous pressure in all of 140 observations made on 35 patients.

AUTHOR.

Greene, Charles W.: The Nervous Control of the Coronary Circulation and Its Clinical Significance. South. M. J. **29**: 478, 1936.

The coronary blood vessels are richly supplied with efferent neurons of both coronary dilator and coronary constrictor type. Of these, the coronary dilator neurons are greater in mass effect, more definite in physiological control, and must obviously serve the primary function of increasing the coronary flow during augmented myocardial work.

Coronary constrictor mechanisms, on the other hand, are more limited, the reaction is less voluminous; but in extreme development this portion of the cardiac mechanism may play an important part in producing attacks of functional angina.

The new concept, that these two great coronary nerve mechanisms are delicately controlled by very definite and specific reflex nervous mechanisms in adaptation to every delicate changing activity of the whole body. These reflexes are primarily coronary dilator in type; nevertheless there may occur associated reflex coronary constrictions.

In pathology of the myocardium, and especially of the coronary vessels, structural changes inevitably reduce physiological resilience and delicacy of adaptive response. Under conditions in which the normal animal reacts by increases in the coronary circulation corresponding to the increase in myocardial work, the pathological heart cannot give the corresponding dilatations of the coronary arterial system. Hence there is failure of adequate coronary blood flow, and cardiac asphyxiation follows. Oxygen want is induced with the resulting spasms of pain.

Of the two processes which can induce anginal attacks, the overfunctional activity of the reflex coronary constrictor mechanisms seems to be of lesser significance than the blocking of functional dilatations by pathology of the vessel walls.

AUTHOR.

Albrecht, H. U.: Concerning the X-ray Diagnosis of Aneurysms of the Sinus Valsalvae of the Aorta. Fortschr. a. d. Geb. d. Röntgenstrahlen **53**: 218, 1936.

This report is based on three cases, one of which is proved by autopsy. The author discusses the radiological signs of aneurysm of the sinus valsalvae. They occur more commonly in the right sinus valsalvae and develop on the right side or anteriorly. They are found roentgenologically as saclike shadows protruding into the right lung field or into the anterior mediastinum, where they may produce erosions of the the aortic valve was made during life.

AUTHOR.

Delherm, L., and Fischgold, H.: Four Years of Cardiovascular Radiokymography. Fortschr. a. d. Geb. d. Röntgenstrahlen **53**: 223, 1936.

The main diagnostic advantages of the kymographic method are its ability to differentiate between aortic aneurysm and mediastinal diseases, to detect diseases of the pulmonary artery, and to differentiate between the vena cava and the organs which contribute to the formation of the cardiovascular silhouette. The method allows one to judge the tonicity and the contractile power of the left ventricle and to analyze the occurrences of extrasystoles, pulsus alternans, and bigeminus.

F. B.

Dahm, M., and Meese, J.: Concerning the Movement of the Mediastinum in Aortic Aneurysm. Fortschr. a. d. Geb. d. Röntgenstrahlen **53**: 265, 1936.

This is a report of observations of aneurysms of the arcus aorta with stenosis of the left main bronchus with demonstration of the movement of the mediastinum observed in the kymogram. A difference exists in the kymographic appearance of the mediastinal movement in lung tumors and in aortic aneurysms.

F. B.

Blackford, L. Minor, Bryan, William W., and Hollar, Emory D.: Calcification of the Aortic Valve. J. A. M. A. **107**: 18, 1936.

In a negro, aged thirty-seven years, with a long history of cardiac pain and a relatively short history of congestive heart failure, the diagnosis of calcification of sternum.

F. B.

Leriche, Rene, and Fontaine, Rene: Indications, Results and Technic in Arteriectomy. Presse méd. **97**: 1953, 1935.

Arteriectomy was performed in 80 cases by the authors during ten years. When an artery becomes thrombosed, its function not only ceases, but it may also act as a focus for peripheral vasoconstriction. Arteriectomy is followed by definite

and lasting vasodilatation as shown by changes in skin temperature and by arteriography. Experiments on dogs show that localized obstruction of an artery produces much more impairment of circulation than resection does. Thrombosis in large arteries is likely to produce not only peripheral vasoconstriction but also secondary peripheral arterial thrombosis at a distance and without continuity with the original thrombosis. Resection of the obliterated arterial segment prevents the vasospasms and produces definite vasodilatation.

In carrying out the resection of the thrombosed artery, it is necessary that the entire thrombosed segment be removed. Therefore, if the thrombosis is very extensive, resection may be impossible. At the onset of thrombosis, the obliteration may be quite limited, and surgical intervention should be carried out early before thrombosis has extended. Localization of the lesion is possible only by arteriography. Arteriectomy should be done only if the obliteration in the artery is complete. It is necessary that the arterial resection be carried out without injuring the origin of the neighboring collateral arteries above and below the lesion. Arteriectomy was carried out in four cases of traumatic obliterations of arteries. Surgical intervention should not be delayed in such cases. Arteriectomy is valuable in treatment of Volkmann's syndrome and of thromboses secondary to cervical rib. If embolectomy is not possible due to delay in seeing the patient, arteriectomy may be the method of choice in the treatment of embolic occlusion. However, in cases in which much time has elapsed and there are signs of impending gangrene, the operation is not successful. In syphilitic arteritis the operation was performed twice, but the subjects died of coronary occlusion. In thromboangiitis obliterans, 34 arteriectomies were done, with 10 failures; 7 had transient improvement of at least three months' duration; 2 had good results, but were not restored to work; and 6 had very good results with disappearance of symptoms and were able to resume their occupations. In arteriosclerosis obliterans, the results were even better, although one patient of the 34 operated on died of gas gangrene. Eight had excellent results, 10 good results, 8 transient benefit only, and 2 showed failures. Operations were often done in the advanced stage of obliterative arterial disease. The arteries upon which the operations were performed were as follows: superficial femoral, 60; external iliac, 3; popliteal, 5; brachial, 9; posterior tibial, 2; anterior cubital, 1. Arteriectomy of the posterior tibial and popliteal arteries may be attended with serious complications, particularly if the obliterative disease is extensive. The best results have attended the resection of the superficial femoral artery. Recognition of the localization of the lesions in this vessel can be made by arteriography, and the authors operate only after they have made arteriograms with thorium dioxide. This allows them to note the exact location of the obliteration, its extent, and the condition of the collateral circulation. If arteriography shows a very poor collateral circulation, arteriectomy is not performed.

The technic of the operation for arteriectomy of the superficial femoral artery is described.

N. W. B.

Book Review

CLINICAL HEART DISEASE. By Samuel A. Levine, M.D., F.A.C.P. Philadelphia and London, 1936, W. B. Saunders Company, 445 pages, 97 figures.

The author states that the purpose of the book is to present, in a simple form, the important aspects of the diagnosis, prognosis, and treatment of heart disease. It is meant to appeal to the general practitioner. No attempt was made to cover in detail the entire field of cardiovascular disease. None of the usual plans of arrangement were adopted. Each chapter is to be regarded as distinct in itself, a brief treatise on the subject. No bibliographic references are included.

The author writes interestingly. He has a simple, direct, literary style, knowledge of his subject, original ideas, and willingness to make dogmatic statements. These qualities make his book a pleasure to read. Most interesting of all are the author's views on matters not yet fully established. The fact that most views regarding disease, unsupported by proof, are sooner or later found to be wrong does not lessen one's interest in reading them.

The chapter on clinical electrocardiography is particularly good, and the reviewer is glad to state that he met with no success in detecting errors of interpretation. The chapters on rheumatic fever and the development of rheumatic heart disease, angina pectoris and coronary thrombosis will prove particularly useful for the general practitioner. On the other hand, a few adverse comments seem justified. It is to be regretted that there is no chapter on cardiac roentgenography. Cardiovascular syphilis, although it may not flourish in the austere atmosphere of Boston, would seem important enough, nevertheless, to warrant more than six pages of discussion in a book on heart disease. Nearly all articles on coronary arteriosclerosis and its complications are contributed by specialists who are likely to be consulted for attacks of stenocardia. This makes them throw angina pectoris and coronary thrombosis into the spotlight, whereas these processes are in reality merely intermediate or terminal episodes in the relentless march of coronary arteriosclerosis toward heart failure. This book is no exception to the rule. One does not obtain an adequate picture of this important disease.

The book may be read with profit not only by general practitioners who wish to acquaint themselves with the subject of cardiology, but also by internists, including cardiologists. As a matter of fact, one ventures to predict that the cardiologists, especially those who are a little weak on the clinical side, will derive as much benefit as anyone else.

C. C. W.

Erratum

In the article, "The Relationship of Tachycardia to Cardiac Insufficiency," by Drew Luten, M. D., in the October issue of the JOURNAL, the sentence beginning on line 14, page 441, should read, "It is known that as the *ventricle fails*, irritability increases[16, 17, 18] and that with improvement it diminishes again."